***R**egional **C**ooperation for*
***L**imited **A**rea Modeling in **C**entral **E**urope*

LACE
nwp central europe

ALADIN

ALARO-1 Canonical Model Configuration Developments and Tests

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Talk outline

- ALARO status
- ALARO developments
  - Microphysics: prognostic graupel development
  - Shallow convection
  - Coupling with SURFEX
    - Roughness treatment
  - *Complementary subgrid drafts scheme*
  - *Cloudiness treatment*
  - High resolution grey zone limit (2.2 km)
- Outlook

Presentation
Luc Gerard

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**: hu, ma
  - **ALARO-1vB**: cz, sk, si, po, be, tr

  model resolution between 8 km – 4 km, 2km

National posters

- In EPS systems
  - ALADIN-LAEF, GLAMEPS, EPS at HMS,RMI

Presentation Martin Belluš

- In climatological simulations
  - be, cz

ALARO-1 versions

- ALARO-1vA
  export CY38T1.bf3, CY40T1.bf7, documentation (February 2015)
  +screen level interpolation (May 2016)

- ALARO-1vB
  CY43T2, back-phased cy40t1.bf7 (January 2017)
  - Shallow convection closure, exponential-random cloud overlaps in radiation and cloud diagnostics, improved sunshine duration and direct solar flux at surface
  - documentation describing namelist modifications

ALARO-1 new version - microphysics

- Prognostic graupel (work of Bogdan B., based on the previous research work of Michiel v. G.)
  - Research code prepared in cy38 and phased into cy43t2 and cy45
  - technical problems have appeared during the phasing, linked to the Intel compiler directives and optimization options
  - Preliminary runs were realized using the ALADIN/Poland configuration, running in Krakow (dynamical adaptation on the 7.4 km resolution grid, done for the period of the year of 2013).
  - For scientific validation the code is planned to be phased in a research branch of CY43T2 (not export, but available later on request).

ALARO-1 new version – shallow convection

- To recall
  - Shallow convection in ALARO-1 is part of the TOUCANS turbulence scheme;
  - Direct parameterization of moist buoyancy flux in a general partly saturated case, for which the lapse rate is:

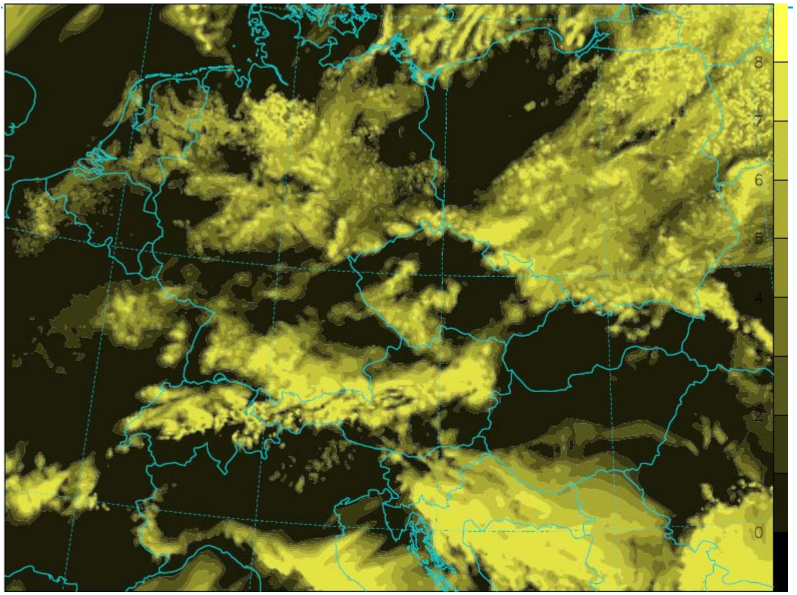
$$\frac{N^2(C)}{gM(C)} = \left(\frac{c_{pd}}{c_p}\right)\frac{\partial ln\theta_l}{\partial z} + \left\{\frac{R_v - R_d}{R} + \hat{Q}(C, C_n)\left[\frac{L_v(T)}{c_p T}\frac{R}{R_v} - 1\right]\left[\frac{R_v - R_d}{R} + \frac{1}{1-q_t}\frac{1}{1+D_C}\right]\right\}\frac{\partial q_t}{\partial z}$$

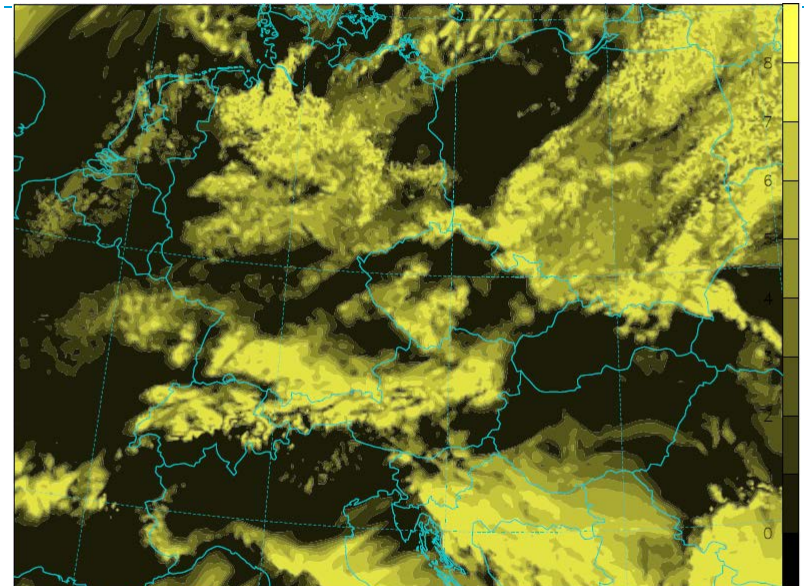
$\hat{Q}(C, C_n)$ Is determined by a simple mass-flux type scheme and by the fit to LES data.

Shallow convection - improvements

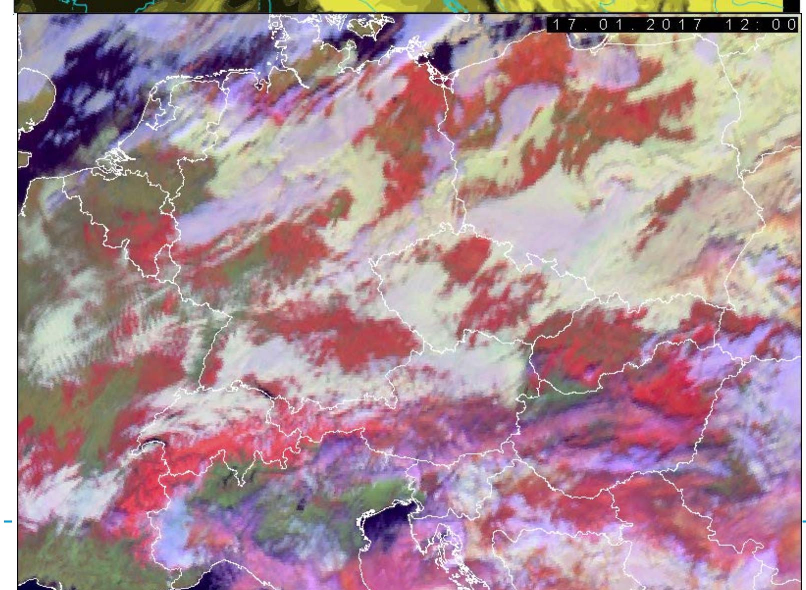
- The list of proposals to further improve the mass-flux type computation leading to the initial determination of the parameter $\hat{Q}(C, C_n)$:
  1. Removal of a combined TKE/TTE threshold to abort the cloud profile;
  2. Taking into account negative buoyancy properly;
  3. Correction of computations determining the “enough thick” stable layer above which there is no new cloud base;
  4. Removal of the saturated stability threshold for the cloud existence.

Shallow convection results (1)

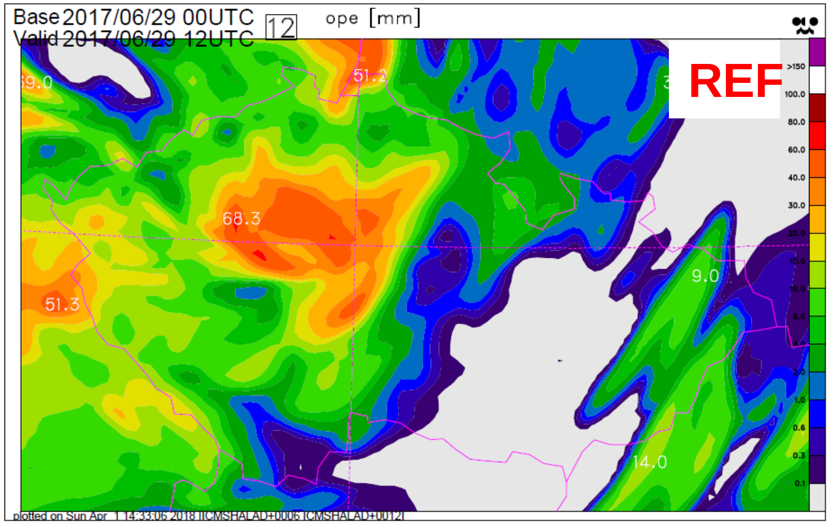




- Winter case of 17/01/2017 – comparison of shallow clouds at 12UTC (+12h fcst)
  - Left up: operational result;
  - Right up: with improved SCC;
  - Right bottom: satellite picture
- Reinforced turbulent transport of water helps to form more clouds.



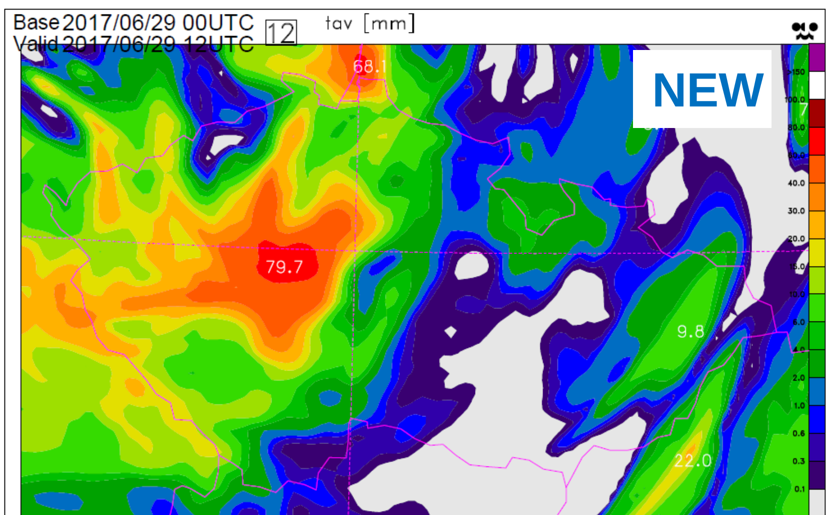
Shallow convection results (2)



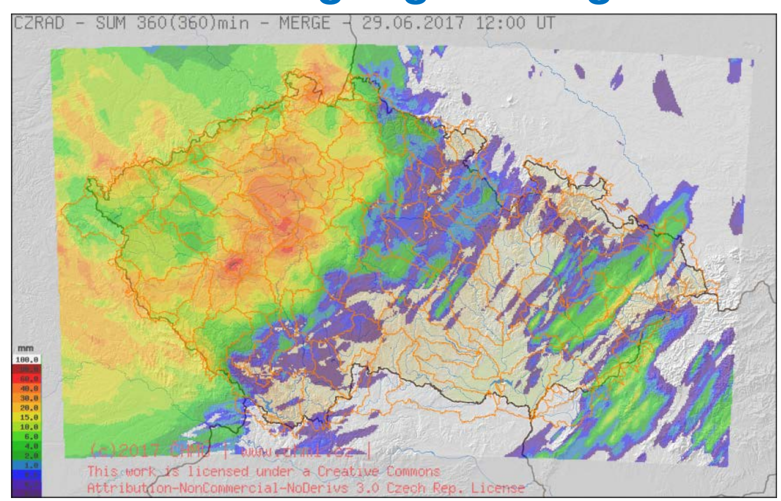
Heavy convective rain case, exceeding 80mm in 6h (!). 12h lead precipitation forecast of 6h sums for 29/06/2017 at12UTC:

REF: operational SCC

NEW: improved SCC by the proposals – better correspondence of the activity locations

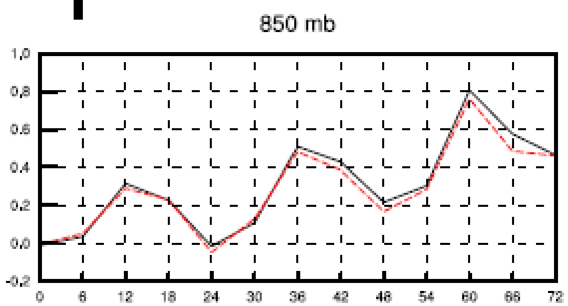


Radar & gauges merge

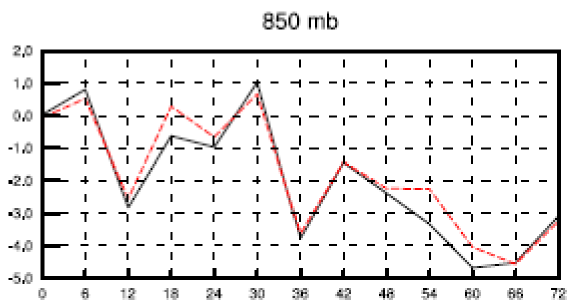


Shallow convection results (3)

T

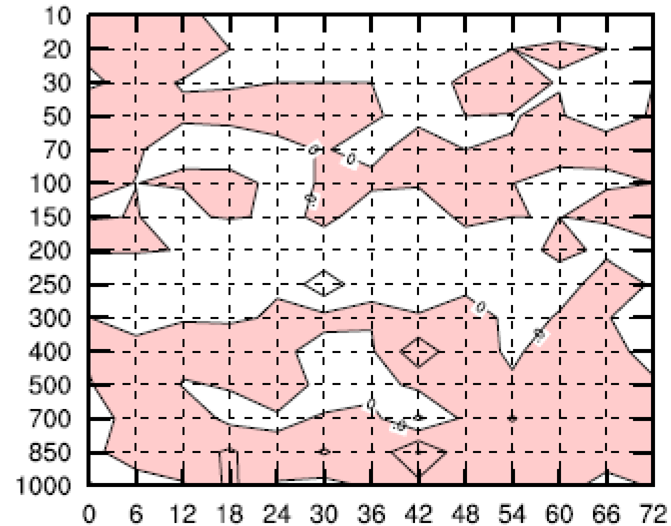


RH

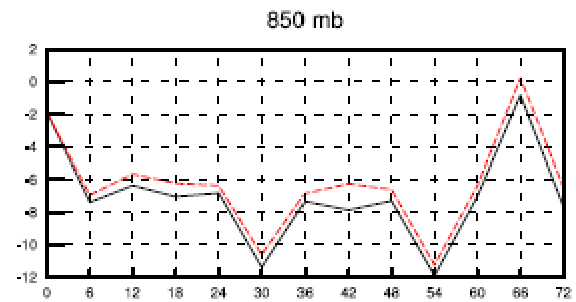


REF
TEST

RH – RMSE diff



RH - bias



Summer e-suite; scores from 22/06 to 10/07/2017. Improved SCC reduces warm and dry bias at the PBL top. RMSE scores within PBL are also slightly improved.

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

ALARO-1 new version - SURFEX

- Cy43t2 with SURFEX(v8), technically is working
  - Daan Degrauwe: modset cy43t2_bf04
- modifications on TOUCANS and SURFEX side
  - Rafiq Hamdi: continuation of work (see his presentation at the previous workshop); current issue: detection of surface temperature fibrilations in the SURFEX run with TOUCANS
- roughness treatment in stand-alone ISBA and SURFEX/ISBA
  - Investigation of roughness lead to discovery of problems on the ISBA side (see below);
  - Roughness treatment inside SURFEX will be still checked;
- comparison of stand-alone ISBA and SURFEX/ISBA: code differences, different file formats, **different data bases**

Roughness

- Motivation to address the issue of roughness:
  - begin scientific validation of ALARO CMC with the SURFEX scheme instead of ISBA;
  - Make progressive steps in the preparation of the surface physiography by the e-923 procedure (ISBA fields) and compare to the so-called PGD procedure results when possible;
  - First step: use thermal roughness without the contribution of the sub-grid-scale orography (e-923 switch LZ0THER=.F. and model switch LZ0HSREL=.T.).
- Still on the ISBA side, we found inconsistencies and/or bugs in computation of roughness and drag coefficients.
- Fixing these offered a quick win in model performance; otherwise the investments shall be oriented to the use of SURFEX.

Computation in presence of snow

- The most severe problem was found for the case of snow (on the side of ARPEGE-ISBA with LVGSN=.T., shared by ALARO-ISBA).
- In total ***3 different (!)*** grid-box snow fractions are used:
  - f^{bg} for albedo;
  - *f'* for computing dynamical effective roughness;
  - *f''* for computing thermal roughness.
- Their values can be dramatically different, for example such as $f^{bg} = 0.97$ and $f' \approx 0.01$ easily in the Alps, requiring in turn strange values of tuning parameters to make the model work.
- In addition, linear instead of quadratic averaging is used:

$$z_{0D}^{eff} = (1 - f')z_{0D}^{nosnow,eff} + f'\,\alpha_1$$

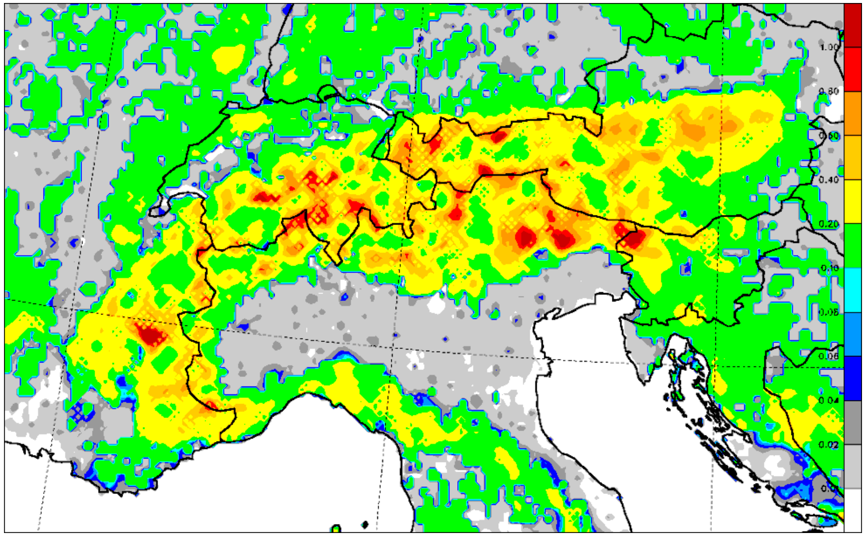
Proposed solution

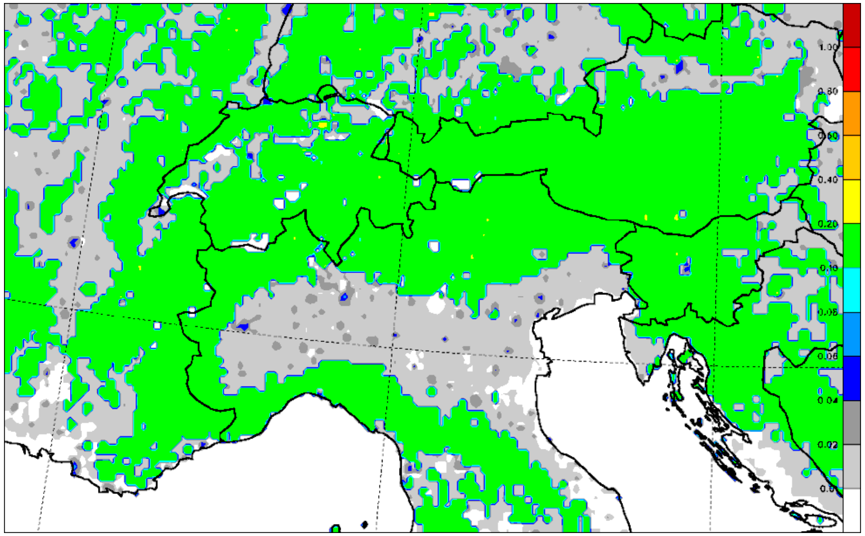
- Correct inconsistencies and bugs that were found.
- Unify computation of the grid-box snow fraction for albedo, dynamical effective and thermal roughness:

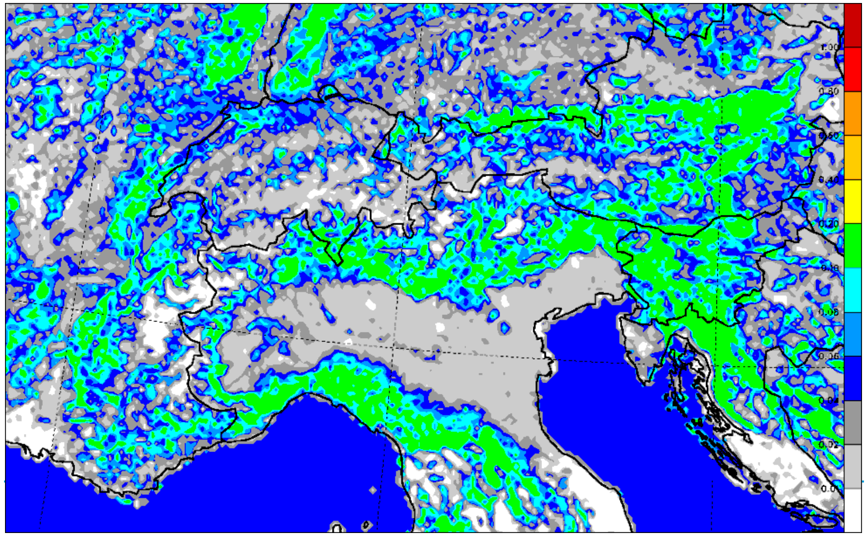
$$f_{snow}^{bg} = \frac{W_{snow}}{W_{snow} + W_{snow}^{crit}\left(1 + \frac{z_{0D}^{nosnow}}{a_2}\right)}$$

- Tuning parameters have now reasonable values and the amplification factor in the denominator can vary from 1 to 1.2.

thermal roughness - comparison

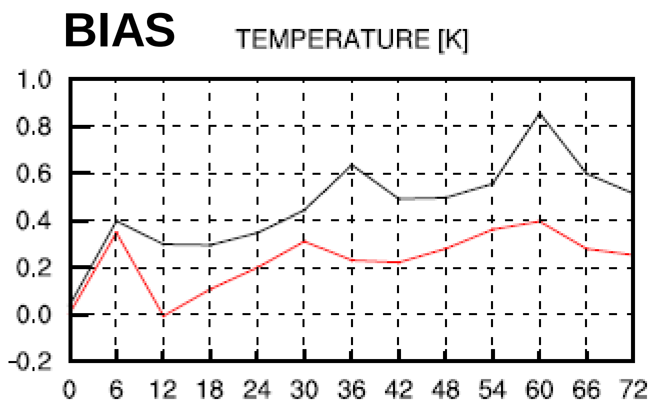


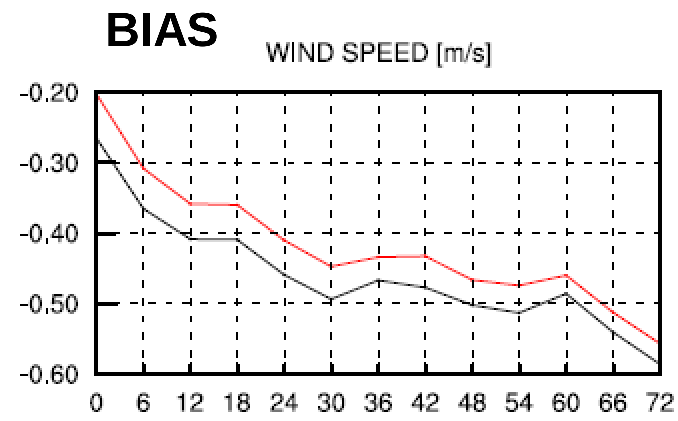




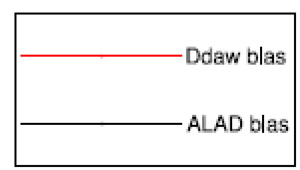
- Left: sub-grid orography contribution is included in thermal roughness (LZ0THER=.T.in e923)
- Right up: recommended LZ0THER=.F. in 923, not to include the orographic term;
- Right bottom: SURFEX case – much more details thanks to the **finer input database, not available in e923 procedure (!)** However amplitudes are comparable.

New roughness treatment - results





Period: 20170114...20170131
Network: 0UTC
SURFACE

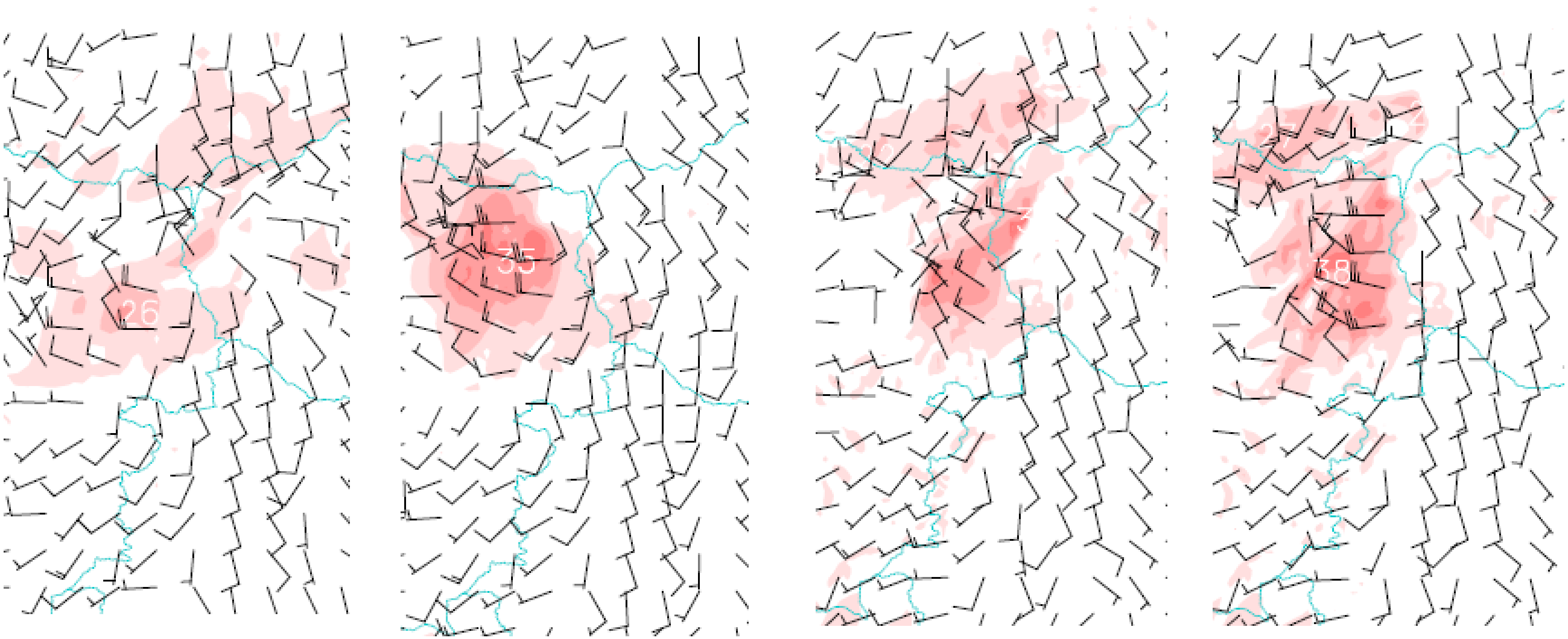


- Impact is seen namely in presence of snow, since the correction was the most important there.
- Test done in January 2017 including the full assimilation cycle.
- Logically, snow surface became less rough; more appropriate tuning of snow fraction computation helps to improve albedo of the grid box.

High Resolution Gray Zone Limit

- New supercomputer in Prague will allow to increase the resolution to app ***2km over LACE domain***;
- At this horizontal resolution we are at the ***"high resolution gray zone limit"*** it is still better to have moist deep convection parameterization active since only the largest drafts can be resolved;
- ALARO CMC can use either the 3MT scheme (nominal now) or the CSD scheme (in future), with non-saturated downdraft scheme replacing the original one used in 3MT.
- Other choices are obvious: non-hydrostatic dynamics and move to the use of SURFEX, here namely due to the availability of fine physiography datasets not exploited via the e923 procedure, e.g. see the thermal roughness fields shown before.

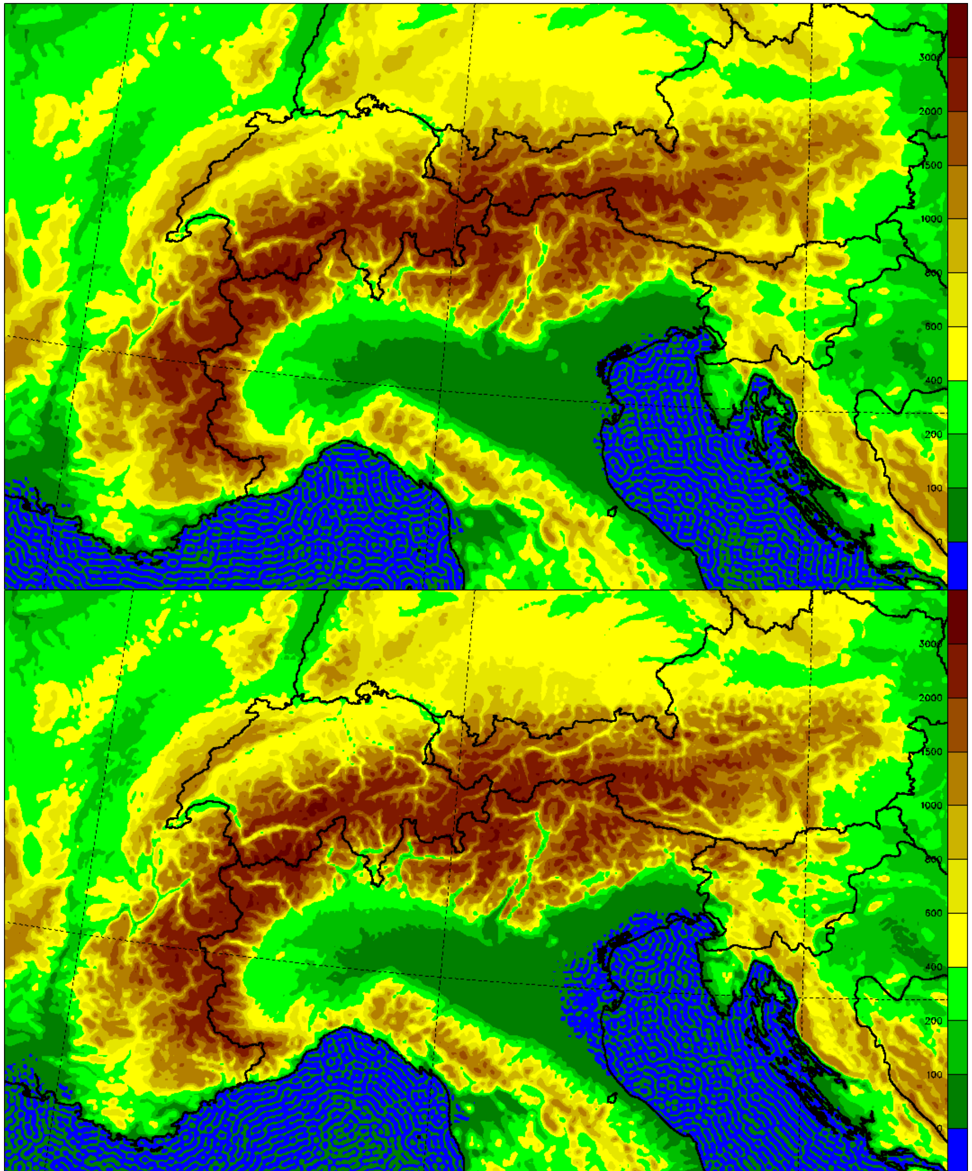
Sensitivity to resolution and deep convection parameterization: wind gusts



3MT, 4.7km | noconv, 4.7km | 3MT, 2.2km | noconv, 2.2km

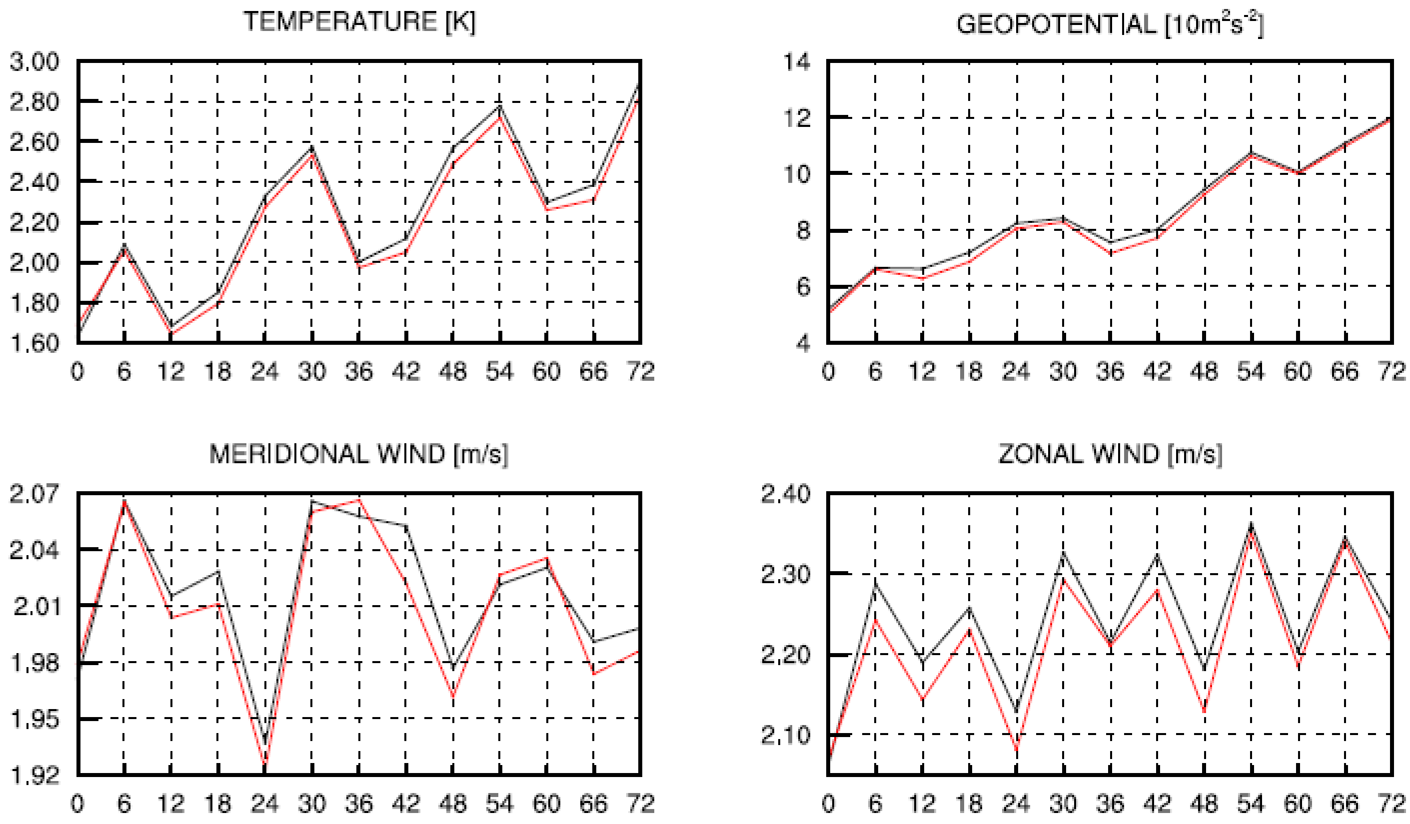
Higher resolution brings sharper surface wind convergence limit. Absence of the moist de
parameterization leads systematically to even stronger surface wind at both resolutions since the dynamics tries to compensate but at a wrong scale.

Orography comparison



- At high resolution of app 2km we see the comparison of orography over the Alpine region.
- Upper picture: result of the standard e-923 procedure with gtopo30 database on the input;
- Lower picture: result of the PGD procedure using finer database; this result can be used straight before ALARO-SURFEX is well validated;
- In both cases orography is spectrally fitted (quadratic truncation).

Scores first check



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TEST

A very quick check of the surface STDEV scores to verify the resolution increase.
Faire comparison is done in the dynamical adaptation mode for 5 winter days.
Scores are improved at higher resolution as expected; the model is taken “as is”.

Outlook of Ongoing and Future Developments

- ALARO with SURFEX
  - Necessity due to the physiography databases anyway;
  - Technically it is working;
  - Scientific validation absolutely needed.
- Enhancements in TOUCANS
  - Mixing length choices, Third Order Moments improvements;
- Microphysics
  - Prognostic graupel scientific validation;
- Unification of cloudiness
- Scientific validation of non-saturated downdraft and CSD to improve the high-resolution gray zone limit.

ALARO-1 - annoucement

ALARO-1 Working days

planned for May/June 2019