*Regional Cooperation for Limited Area Modeling in Central Europe*

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# LACE physics development

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# Determination of the orographic and vegetation roughness in the ALADIN model at CHMI 2020

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- Technical work (preparation of climatological files) towards using GMTED2010 instead of GTOPO30, and benefit from ECOCLIMAP I, II, SG
- Wind speed verification over Central Europe (600 stations) with ALARO 2.3 km at CHMI for orographic roughness length calculated from GMTED2010 **with**/ without scaling and smoothing
- Similar experiment with vegetation roughness length with ECOCLIMAP I and **ECOCLIMAP II** with the same smoothing

# Investigating SURFEX in ALARO-1

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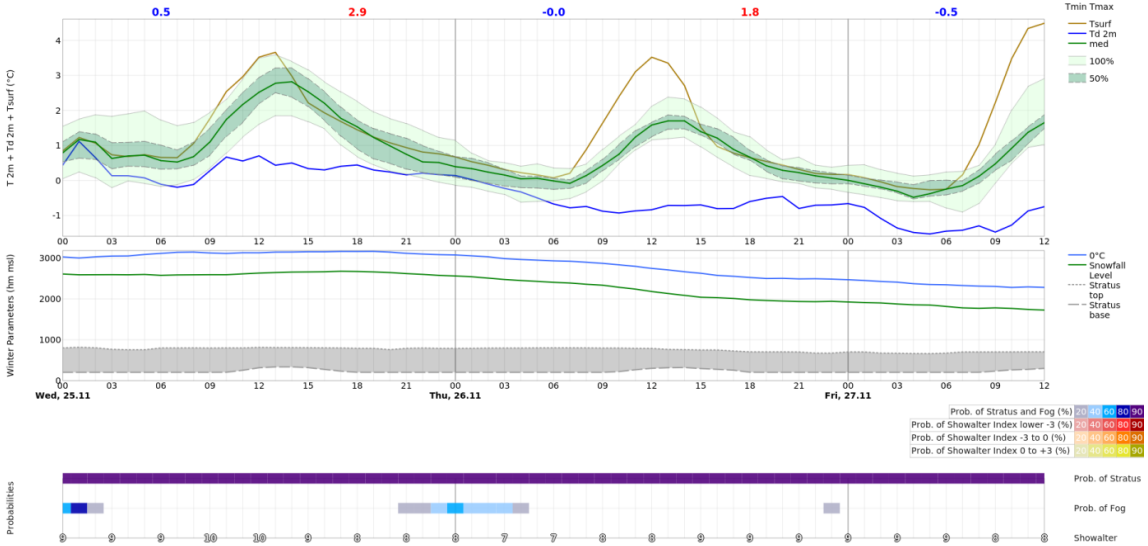
- Problem with surface Richardson number (large area of exaggerated night cooling in SURFEX)
- Problem with heat coefficient (differences in the lowest model level temperature)
- Problem with fibrillations in SURFEX (switch off antifibrillation treatment)

# Additional Model diagnostics (Au)

- Stratus Diagnostics is currently implemented in local AROME branch at ZAMG (diagstrat.F90)
- Modifications/tunings were performed to extract information on stratus top and base height by scanning vertical columns
- Use for AROME/C-LAEF/AROME-RUC
- e.g. meteograms/epsgrams



# AROME Screening Level diagnostics, LCANOPY (Au)

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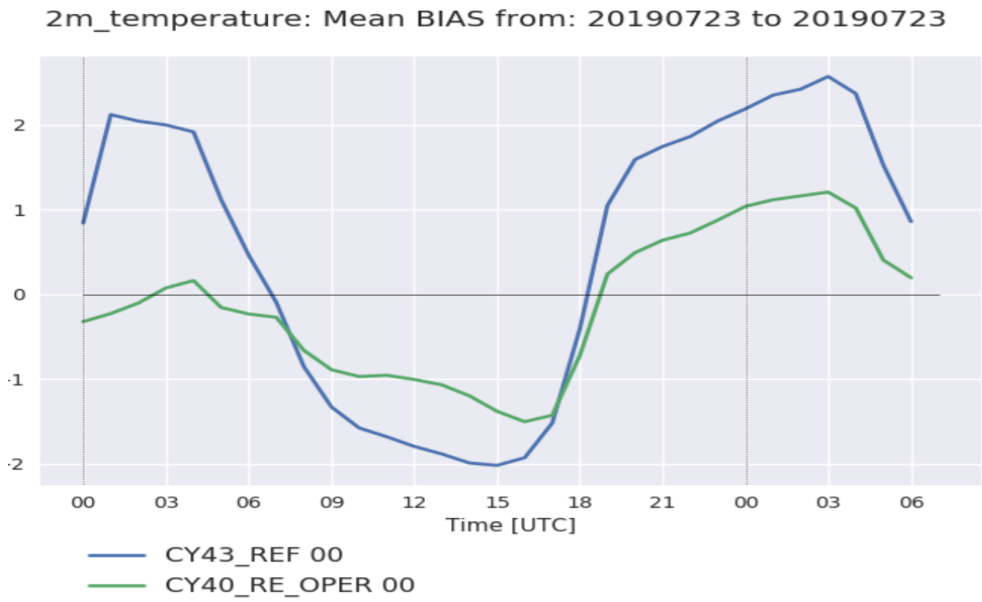
- Comparing AROME operational cy40 (green) vs. cy43 (blue): significant stronger bias was observed in cy43, in particular in Alpine valleys during clear nights
- First suspicion: Orography, Why? With cy43 we want to change from GTOPO to GMTED -> cy43 gmted, cy40 gtop
- But it turned out: Changing orography (GTOPO vs. GMTED vs. GMTED filtered) does not explain this behaviour
- -> orography is not the reason!




AROME cy43 (blue) with significant higher warm bias in Alpine valleys in clear nights



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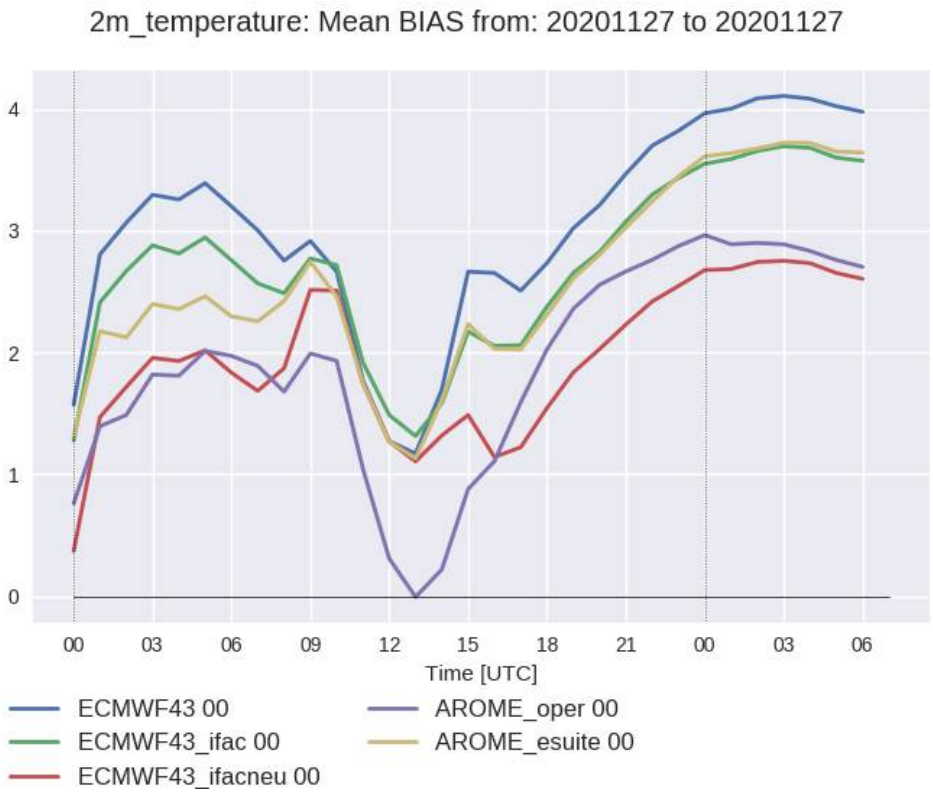
# AROME Screening Level diagnostics, LCANOPY (Au)

- modified diagnostics for LCANOPY improves results, in particular for stations in Alpine valleys (see blue line vs. red line)
- Running in E-SUITE currently
- Seems to be good temporary solution; but long term goal: switch to LCANOPY=F



# AROME Screening Level diagnostics, LCANOPY (Au)

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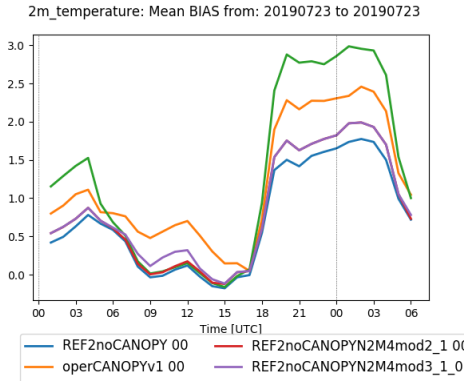
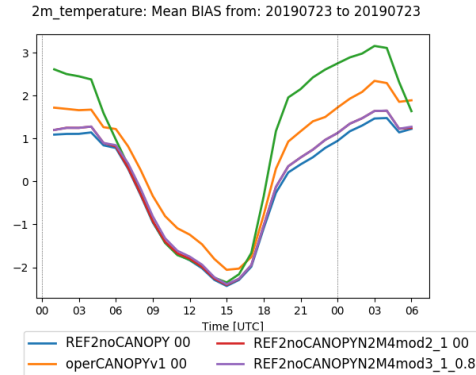
- Plan to move from LCANOPY=T -> LCANOPY=F
- Try switch off CANOPY and use Geleyn/Dian 2016 scheme

- Work done:
  - Geleyn scheme is differently coded in SURFEX than in old ISBA2L (equation weight for T only instead of static energy cpT/cpsTs). Why is this the case?
  - Code modified (to have Geleyn_surfex = Geleyn_ISBA); tested for few cases -> negligible impact (maybe this answers question raised in 1) ?)
  - Dian2016 was coded in SURFEX (as options N2M=3,4); tests performed; currently running in an AROME-RUC Esuite




Clear sky experiment:
Blue: Geleyn
CANOPY standard version
Dian (stable only coef=1.0)
Dian (stable coef 1.0/unstable 0.8)



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# TKE-based mixing length

- Ongoing work on implementation of TKE-based mixing length in TOUCANS.
- The starting point is revised $L=L_{TKE}$ formulation, with smooth transition from the surface “κz” layer to the upper layer where pure TKE-based solution ($L_{TKE}$) prevails.
- On top of that there is so-called “crossing parcels” treatment, which significantly improves the model performance during the summer convection

# TKE-based mixing length

- Starting formulation is further upgraded by setting the free atmosphere lower bound on $L_{TKE}$ and consequently $l_m$.
- At first it was set as a constant value (for all conditions; $L_{TKE}$=180 m), which is also done for the referent Geleyn-Cedilnik formulation. This modification resulted in necessary increase of mixing in middle and upper PBL and to smaller extent in the lower PBL. It also resulted in drying the surface layer and moistening of upper PBL, as well as reducing the difference of the magnitude of individual terms (DDH budgets) compared to the reference.
- The impact on temperature is smaller and significant only near the surface. The concept of free atmosphere lower bound is further upgraded by allowing its variation depending on the maximum of $L_{TKE}$, which shows strong daily and seasonal variability. This resulted in necessary additional warming and drying of the surface layer, as well as further moistening of middle and upper PBL.
- The verification scores are significantly improved and TKE-based formulation is now comparable to the reference, both for summer and winter.

# TKE-based mixing length

There are still several options for “internal improvement”:

- selection of the moist suitable averaging operator to enhance mixing where/ when needed (with CP, $L_{up}$ and $L_{down}$ may be very asymmetric)
- test the impact of the complementary method for estimation of $H_{PBL}$ (default method gives too deep PBL in stable conditions and/or too big local variations) – direct impact on the depth of the surface “κz” layer and transition layer towards the aloft layer where pure $L_{TKE}$ solution prevails
- testing internal tuning parameters: ETKE_C0SHEAR (impact of the shear term in BL89 integrals), C_EPSILON (magnitude of the TKE-dissipation; without touching stability functions) and ETKE_R1/2SIM (two parameters included in the computation of $f_w$ – upper and lower bound of the transition layer)
- “External improvement”, i.e. tuning of other schemes (deep convection is already opened)

# Prognostic graupel

- Two more bugs found lately. First was to include graupel precipitation flux into the total solid precipitation flux to account for the surface variable tendencies. Second one was responsible for changing results (when the prognostic graupel got activated) when changing parallelization, e.g. number of MPI ranks. It was a mistyping in the routine APLMPHYS.
- Tests of precipitation type fields with prognostic graupel were done in Poland. Proposed tuning of parameters will be presented in report.

# Prognostic graupel scores for 22.02.2021 – 22.03.2021

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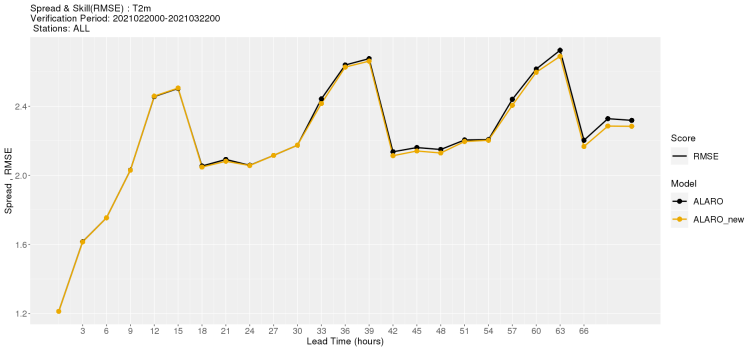
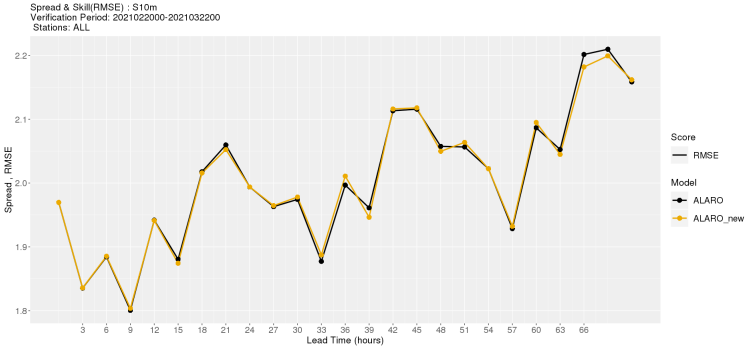
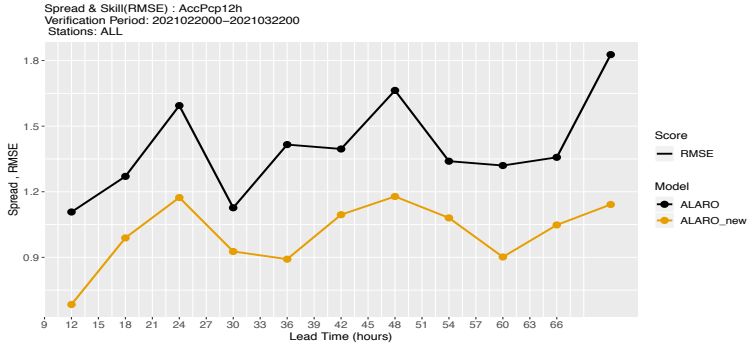



T2m

Validation of e-suite with prognostic graupel in Poland is running. Scores of point-to-point and SAL verifications shows similar results compare to reference run with diagnostic graupel.




S10m




12h Precip



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# Prognostic graupel scores for 22.02.2021 – 22.03.2021

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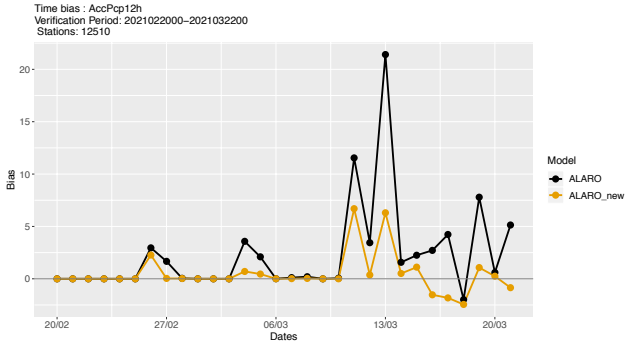
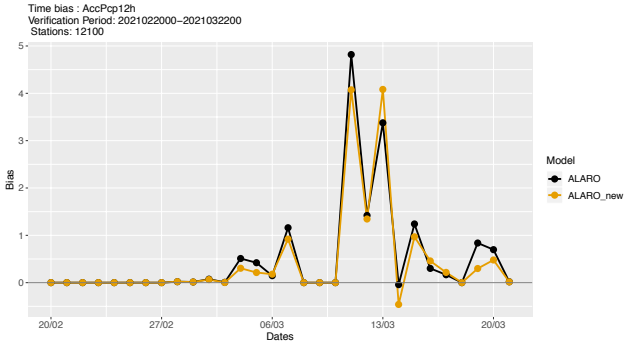
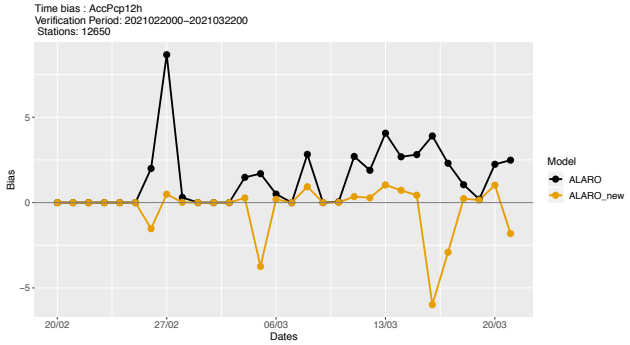
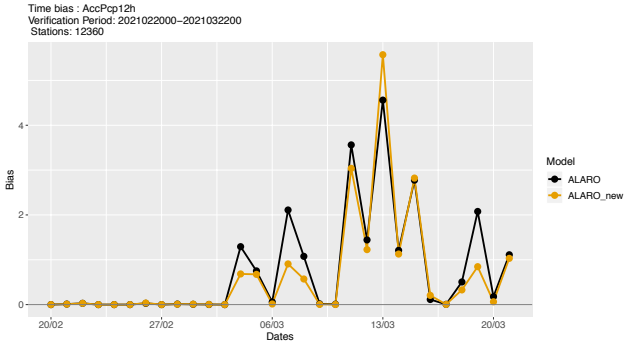
## BIAS for 24 h precipitation for all dates




Mountain stations

Flatland stations



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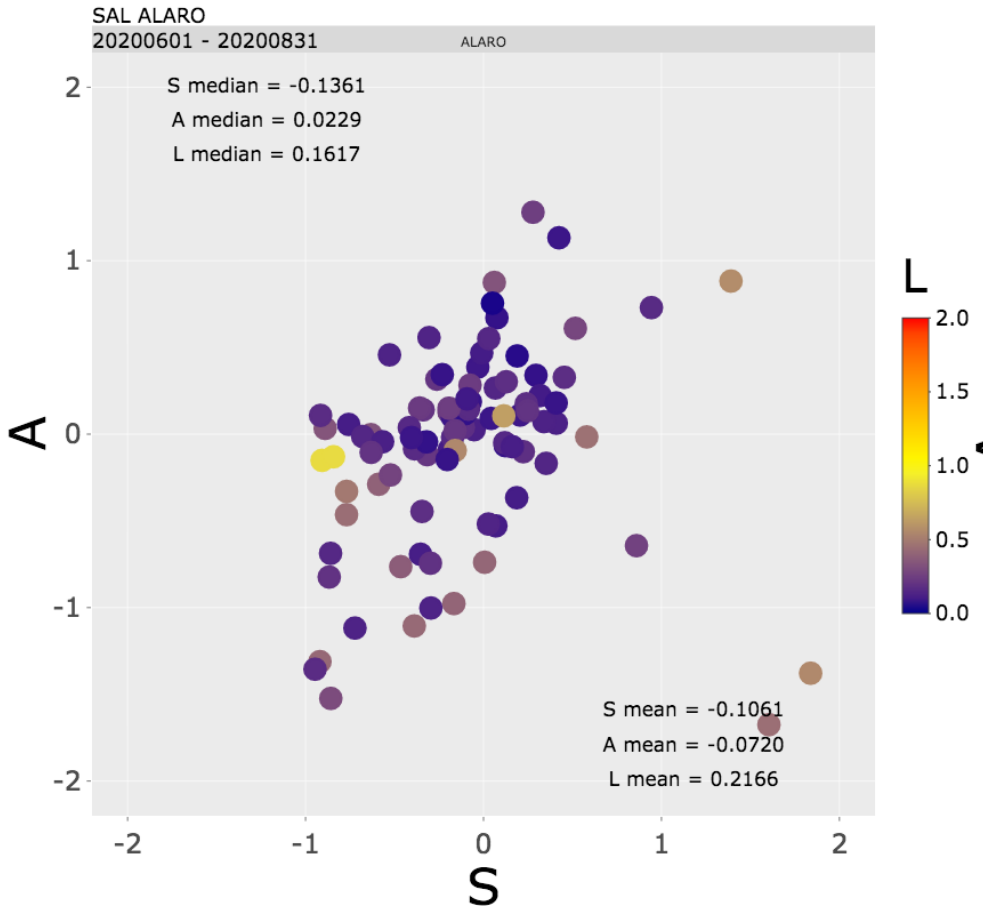
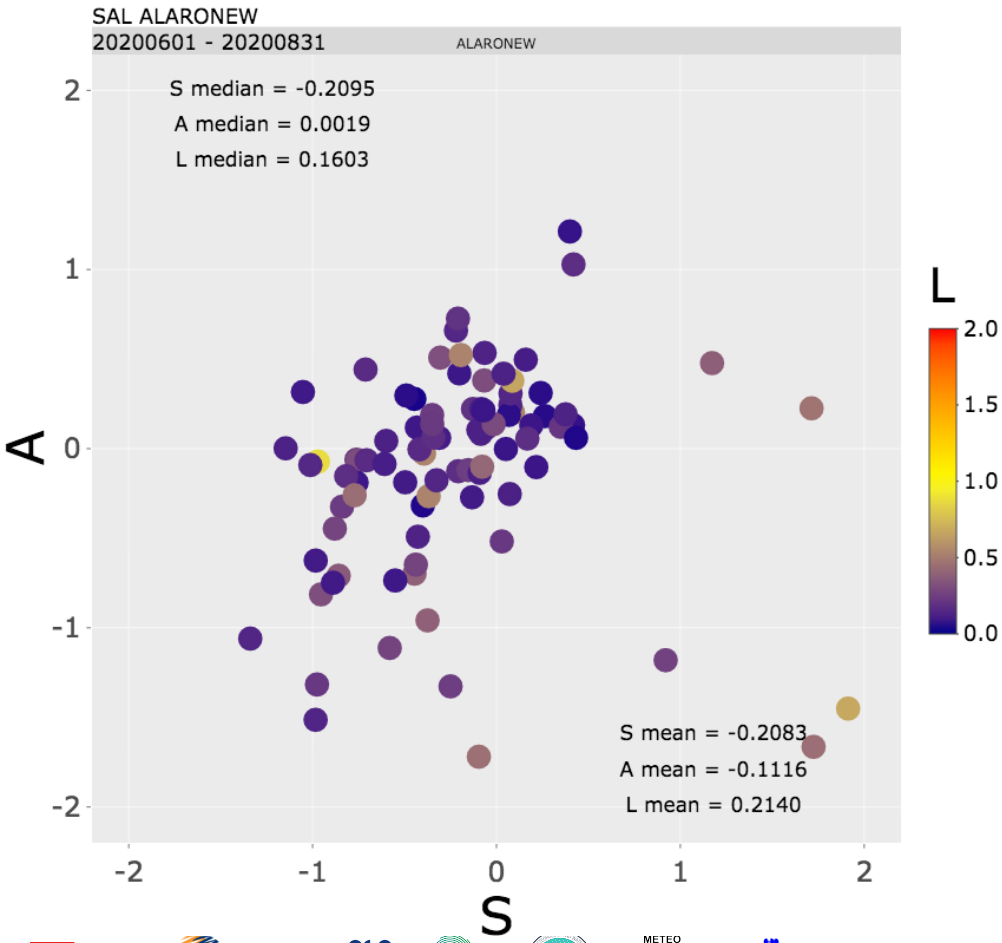
# Prognostic graupel



# VHR tests
# Odd outflows over water surfaces in non-hydrostatic ALARO/AROME models

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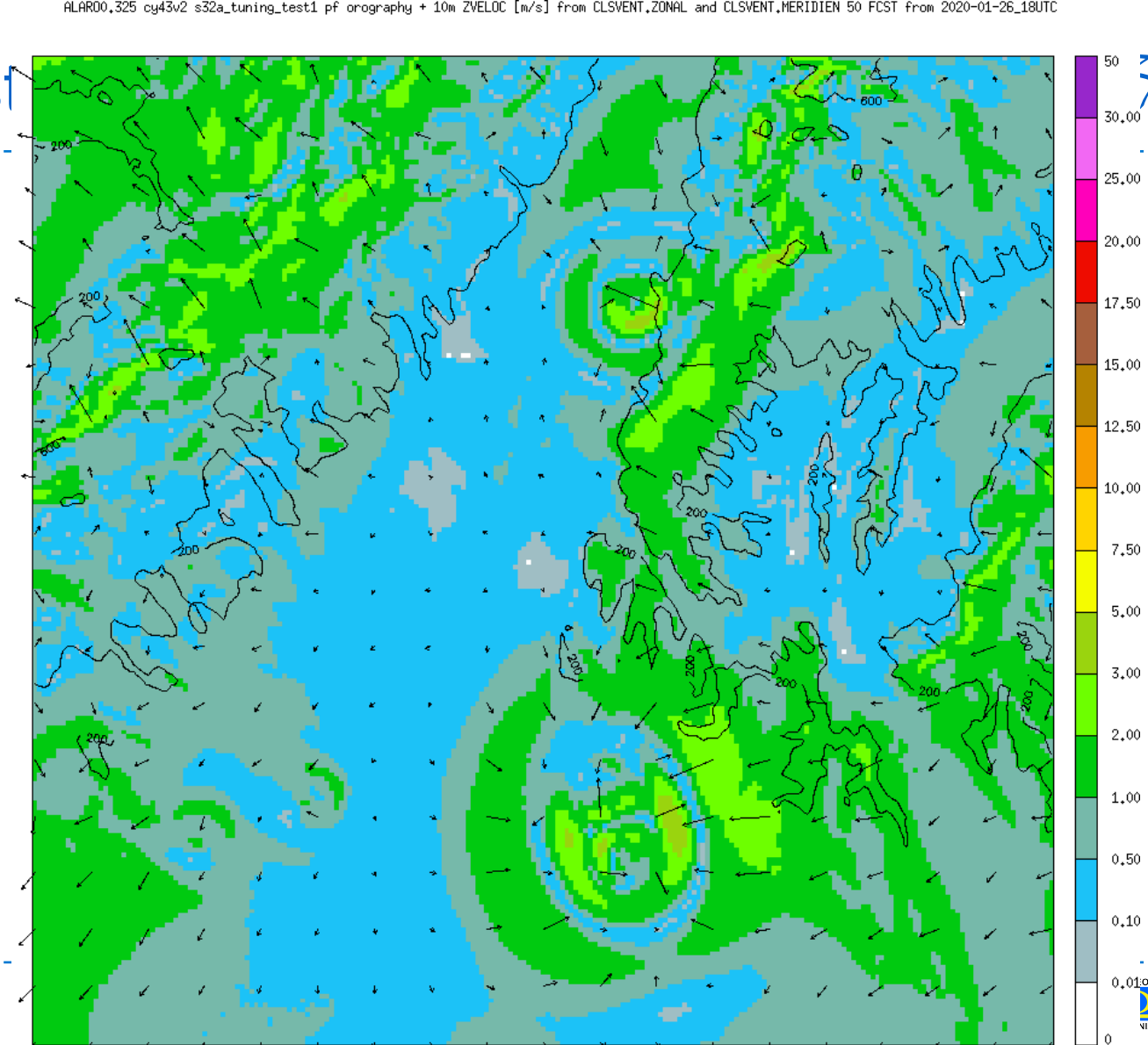
- The phenomenon was already recognized in 2019 in operational AROME model at OMSZ as an outflow and wave spreading very fast from the Balaton Lake shores. The model was exceptionally run as pure dynamic adaptation due to sudden technical problems, in "normal" runs with assimilation it did not occur

- Very similar traits could be recognized in outflows in high-resolution (325 m) experimental dynamic adaptation run for the domain of Slovakia (NH dynamics, cy 43). The concentrically spreading 10m wind velocity maxima indicated a problem with convection but appearing in very stable stratification on 26 January 2020 (12 UTC run). Animation follows….

# VHR test

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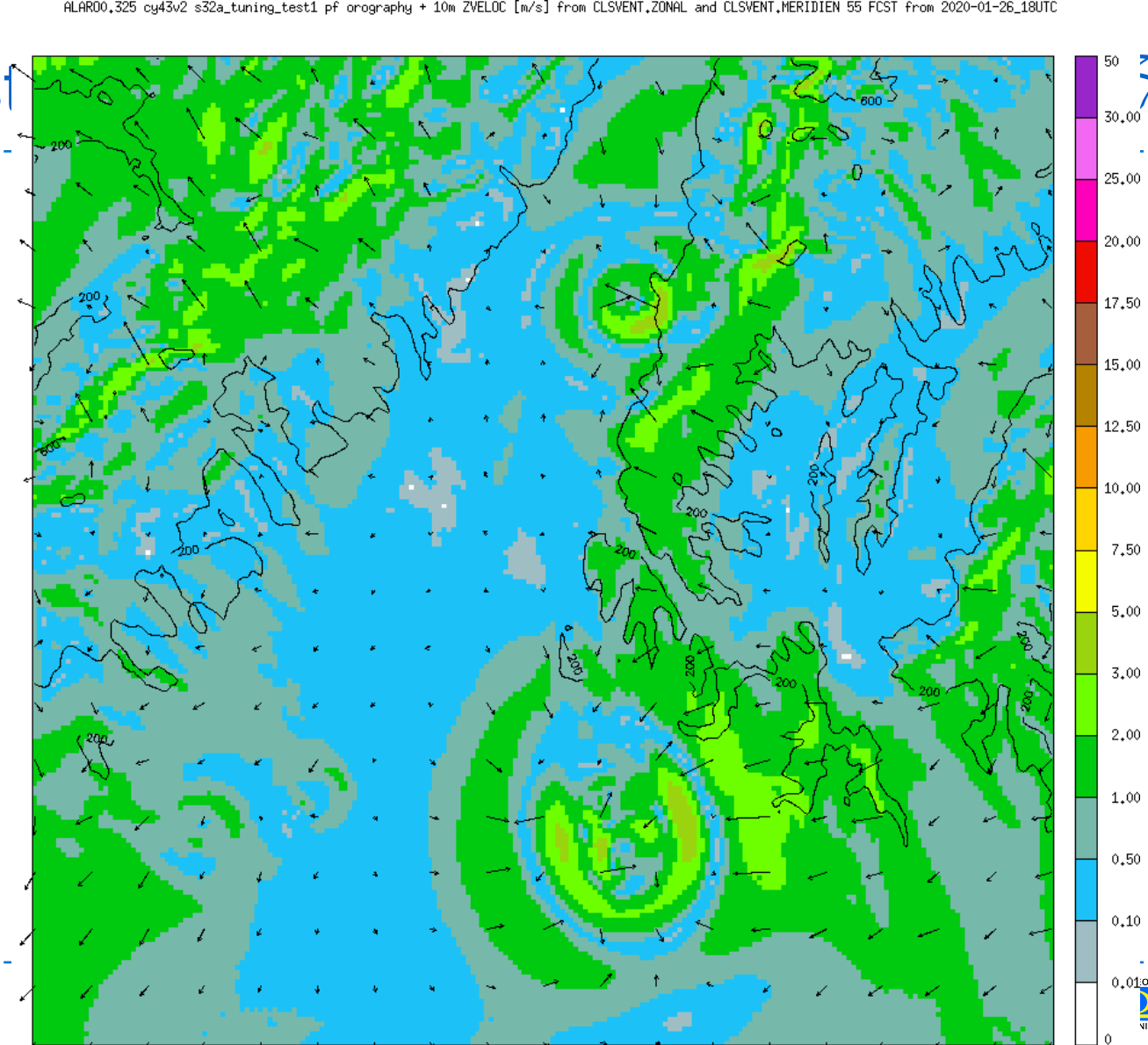
# VHR test

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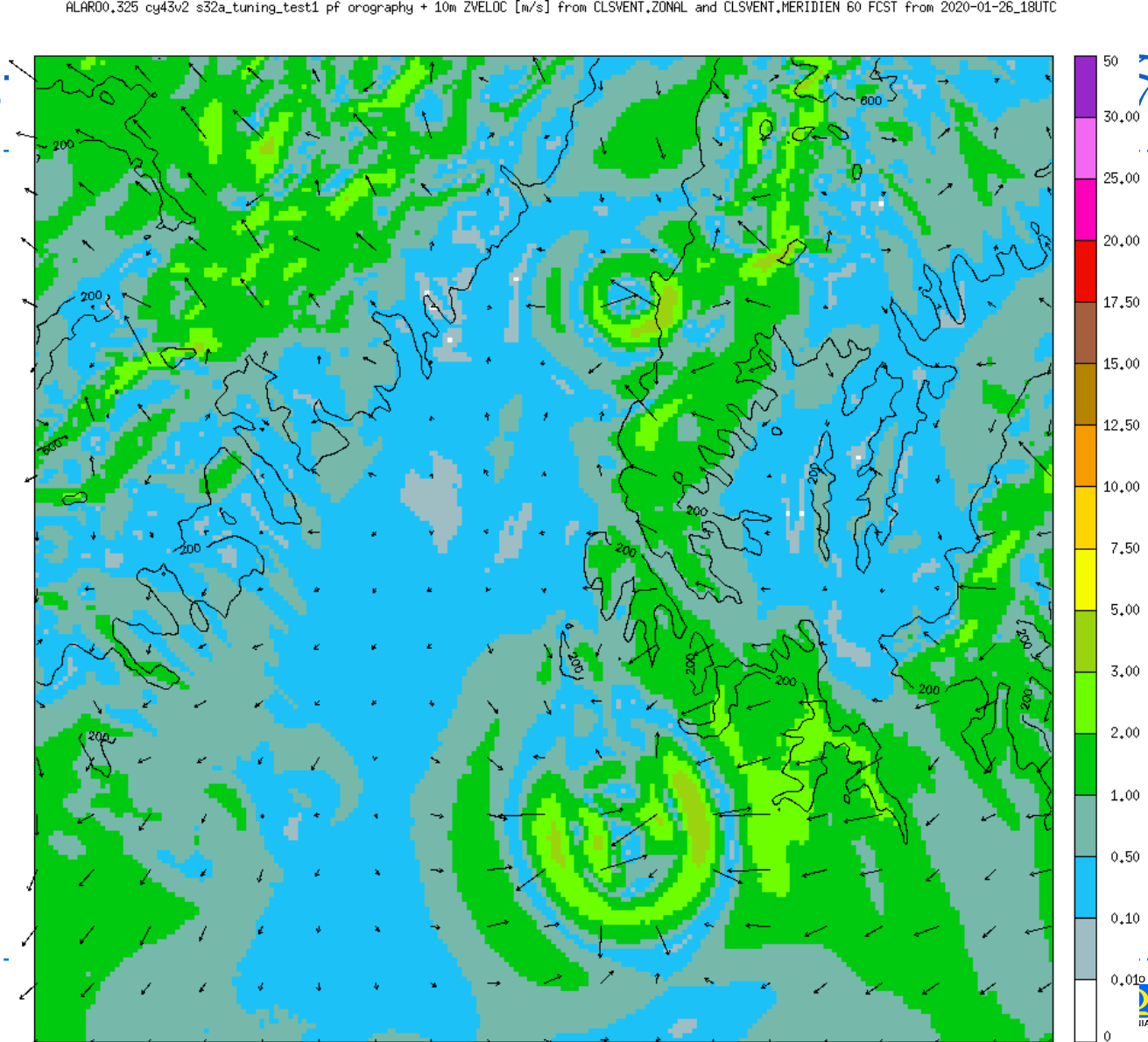
# VHR tes

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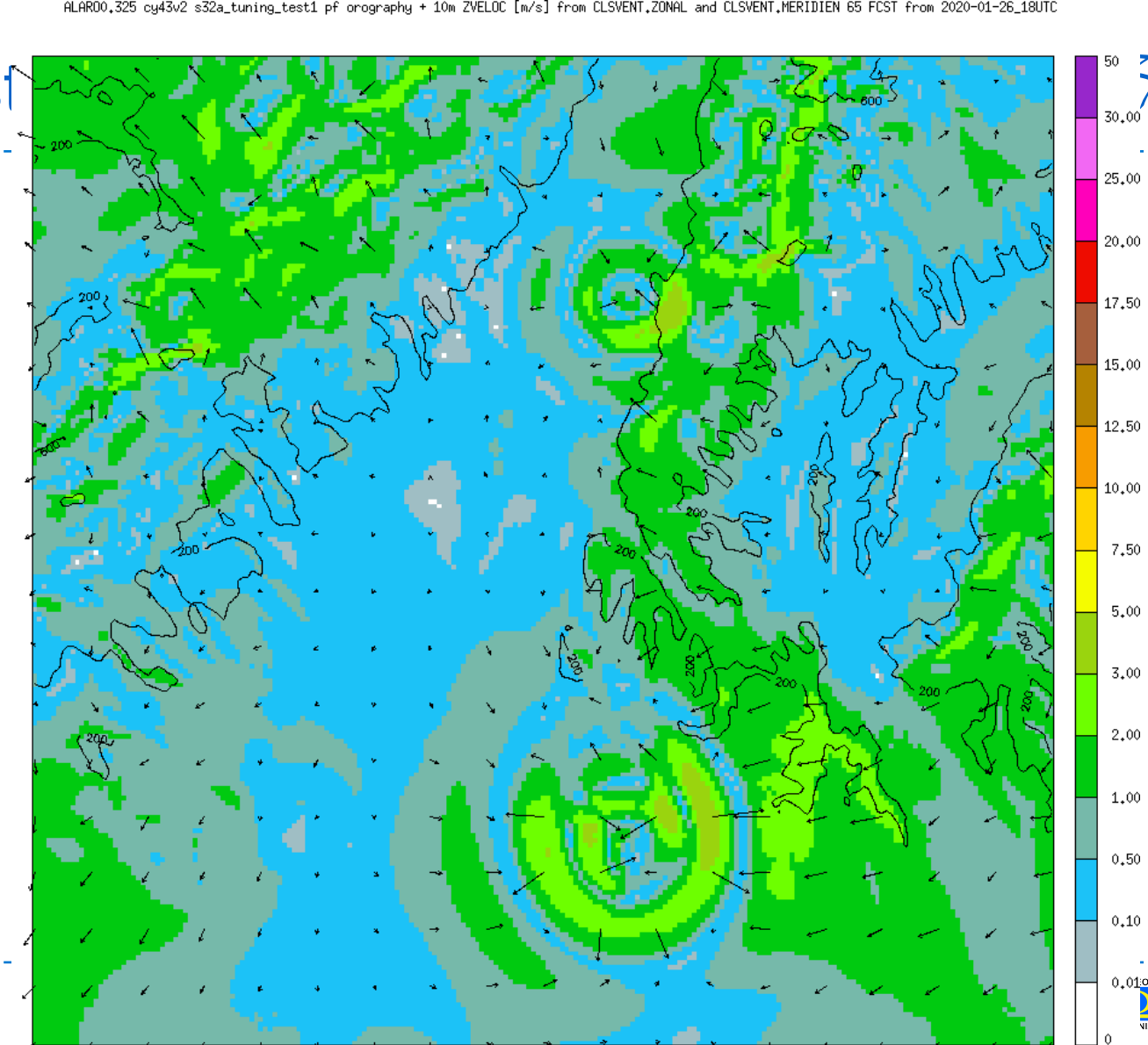
# VHR test

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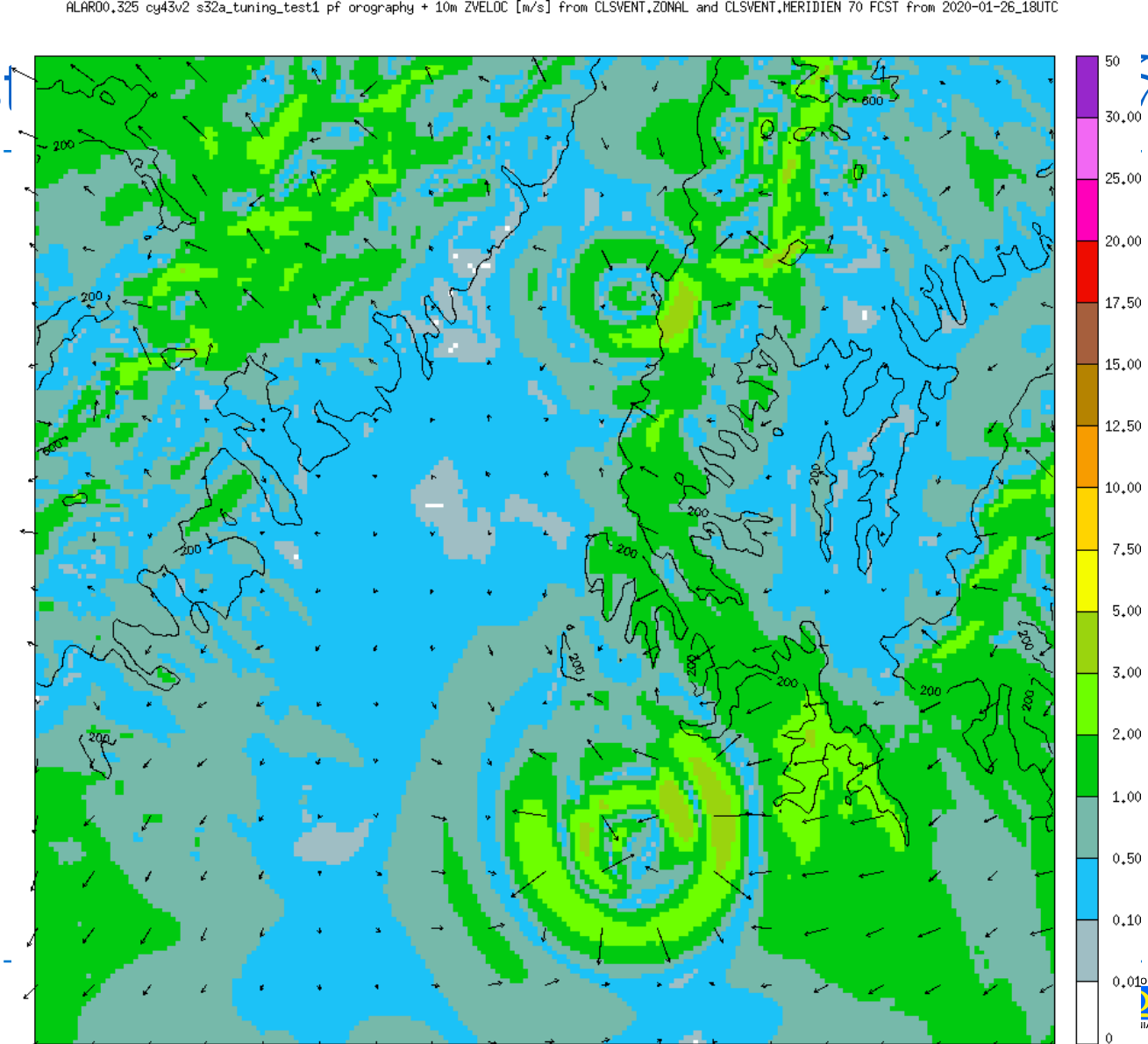


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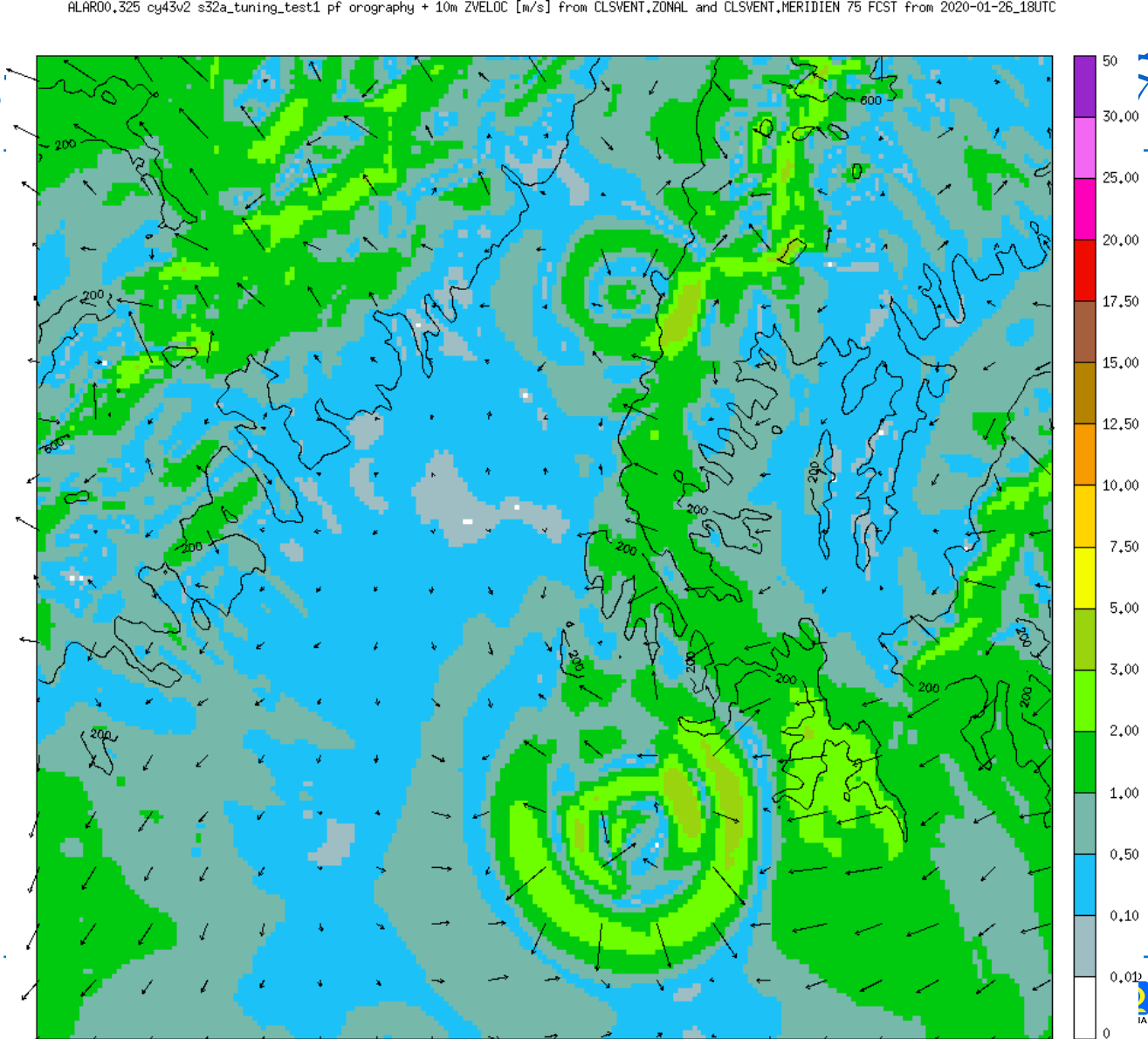


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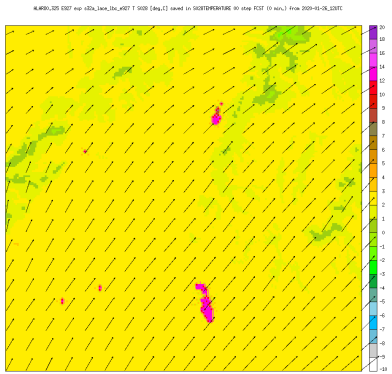
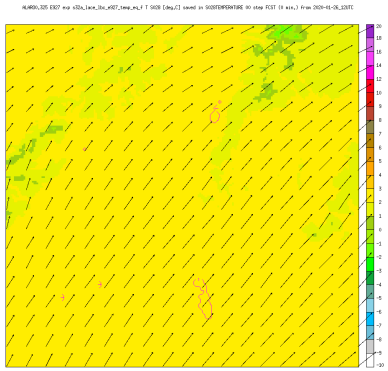
# VHR tests

The vertical cross-sections reveal an interesting fact that the temperature anomaly over the lakes was created in the e927 configuration due to vertical interpolation. Not at surface but about 1400 m high. Switching LESCALE_T=.F. In e927 “cleaned” the anomaly, which otherwise induces deep convection immediately …





# VHR tests

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Comments

- Although the presented problem was artificial, lake-induced convection does exist. This can cause snowstorms (e.g. at large lakes as Great Lakes in the USA) and local thunderstorms - especially by warm-water shallow lakes as Balaton or in the tropics (Lake Victoria)

- At high resolution, there are already many local heat sources, not only lakes and water surfaces but also urban areas, soil/vegetation patterns, etc. However, in stable stratification, shallow heat sources should not induce deep convection as shown in the cases above

- It is probable that one would not observe such violent effects in a hydrostatic model. This problem was visualised thanks to non-hydrostatic dynamics and it is possible that it could even cause numerical instability under some circumstances (as by LESCALE_U=.T.)

- The next task would be to find how to keep positive features of the vertical interpolation, while not inserting new anomalies from too warm surfaces

# Some problems?

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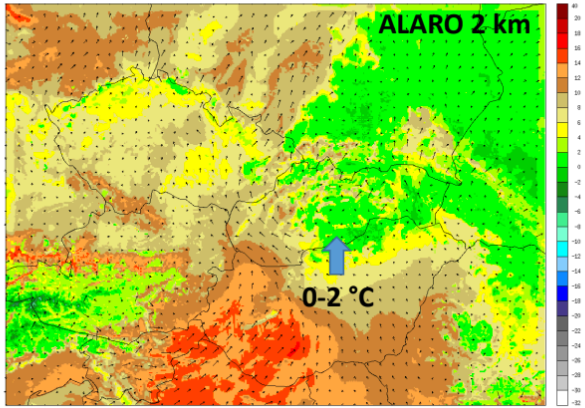
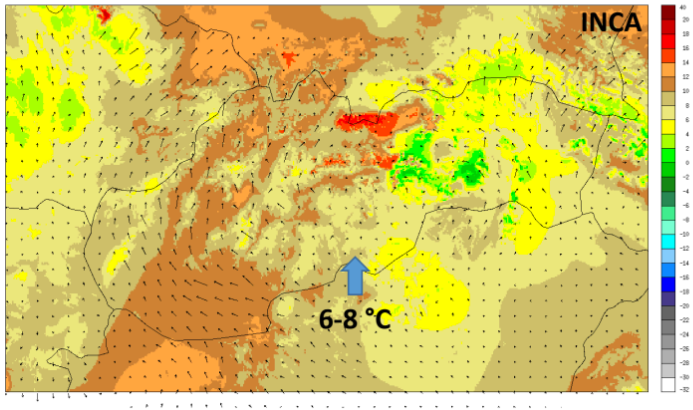
## High spread and underestimation of 2m temperature over snow cover in case of the 22 February 2021 warm air advection

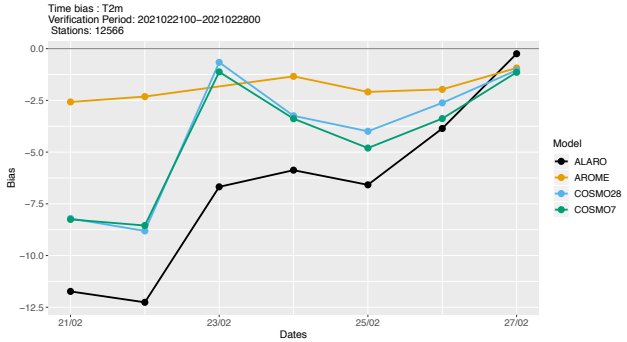
André Simon, Martin Belluš

12h forecast valid for 12 UTC:




Analysis valid for 12 UTC



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# Thank you for your attention.

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