Regional Cooperation for Limited Area Modeling in Central Europe

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Physics parametrisations developments and plans in RC LACE

Bogdan Bochenek

ZAMG DHMZ Czech Hydrometeorological Institute OMSZ IMGW METEO ROMANIA SHMU ARSO METEO Slovenia

Preparation of clean SURFEX modset for ALARO

- Investigation of the roughness length treatment in SURFEX revealed several inconsistencies between original ISBA implementation and SURFEX, as well as some bugs on the SURFEX side.
- It also turned out that some tunable ISBA parameters, important for NWP, are hard-coded in SURFEX.
- A modset correcting these drawbacks was prepared and partially validated.
- There are still some issues to be addressed; the modset is intended for NWP commit.
- Modset documentation is in preparation.

Tool for update of e923 clim files on belenos

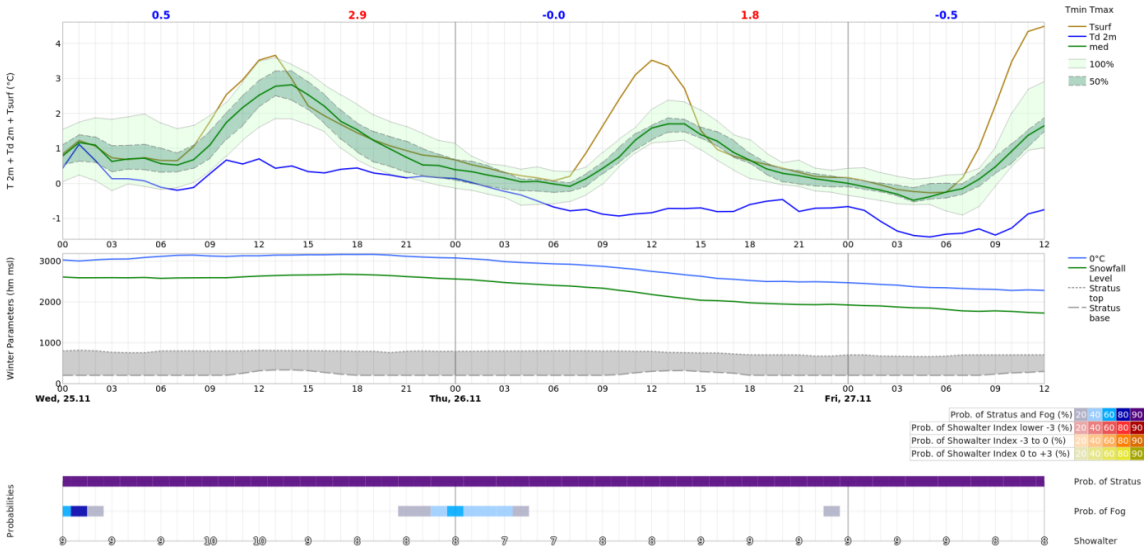
- While ALARO with SURFEX is not operational, it is desirable to benefit from the new topographic (GMTED2010) and physiographic (ECOCLIMAP) datasets on ISBA side.
- Since e923 configuration was not interfaced with these new datasets (except from the mean orography and land-sea mask), a procedure for transferring the subgrid-scale orographic fields (standard deviation, anisotropy, orientation of the main axis) and roughness lengths (subgrid-scale orography and vegetation) from PGD and .sfx files into e923 clim files was made available on belenos.
- It can be extended by other parameters (soil and vegetation characteristics, albedo and emissivity). Such step is highly desirable in high resolution, since the quality of some old e923 datasets is questionable.
- On the other hand, modified surface and vegetation characteristics alter model results dramatically, so that retuning of ALARO with SURFEX datasets will be necessary.

Mixing length computation

- From the development point, the TKE-based mixing length formulation is almost completed. However, its performance can be further improved in cloudy conditions where mixing is underestimated.
- Similar to what is done in ARPEGE, the intention is to use the information about the cloud depth from the shallow convection scheme and compute upwards and downwards displacement of air parcel at least as a distance from cloud top and cloud bottom.
- After that, it will be necessary to perform internal tuning of the TOUCANS scheme as well as other schemes.
- In parallel with this work, a paper on development of TKE-based formulation in TOUCANS is being prepared.
- https://www.rclace.eu/File/Physics/2020/RC_LACE_report_MH_2020.pdf

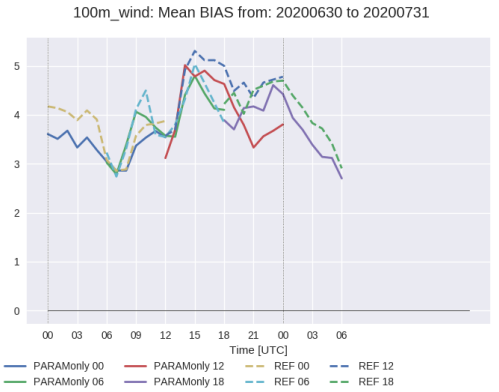
Additional Model diagnostics (Au)

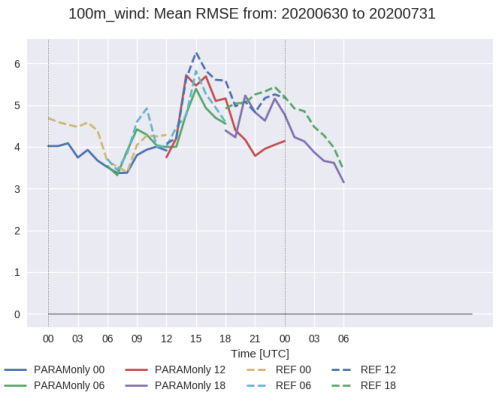
- Stratus Diagnostics is currently implemented in local AROME branch at ZAMG (diagstrat.F90)
- Modifications/tunings were performed to extract information on stratus top and base height by scanning vertical columns
- Use for AROME/C-LAEF/AROME-RUC
- e.g. meteograms/epsgrams



Windfarm parametrisation in AROME

- The windfarm parametrisation following the approach of Fitch et al. 2012, was already coded into AROME cy40t1 in 2017 and is currently locally available for cy40t1 and cy43t2.
- Phasing of it is planned for cy48t2
- The parametrisation provides tendencies for horizontal wind (U,V reduction) and TKE production in apl_arome.F90.
- The apl_arome.F90 routine calls then during 001 each timestep the parametrisation and gets in return the three tendencies using also rotor diameter and the wind and turbine type dependent thrust and power coefficients, which are listed in the parametrisation routine aro_windfarm.F90 itself





Diagnostics of subgrid maximum wind in ~5 km resolution models

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- Work started in 2020 as the operational ALADIN/SHMU systematically underestimated wind in Slovak mountains. A product showing the unresolved wind speed or wind gust has been developed with aid of 325m dynamical adaptation runs on 88 cases with strong wind
- The comparison of mean and maximum subgrid data showed high sensitivity of the wind excess on TKE, wind shear or orography standard deviations, which enabled to parameterize the subgrid wind in model with coarse (5.2 km) resolution
- To achieve higher accuracy, the parameterization was made dependent on the mechanical roughness parameter $z_{0,}$ this approach could be also helpful in better specification of the wind gust scheme (FACRAF)

Diagnostics of subgrid maximum wind in ~5 km resolution models

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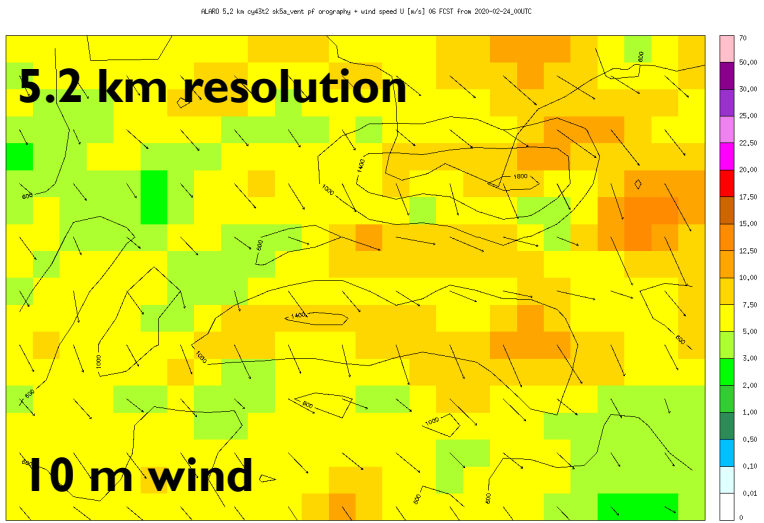
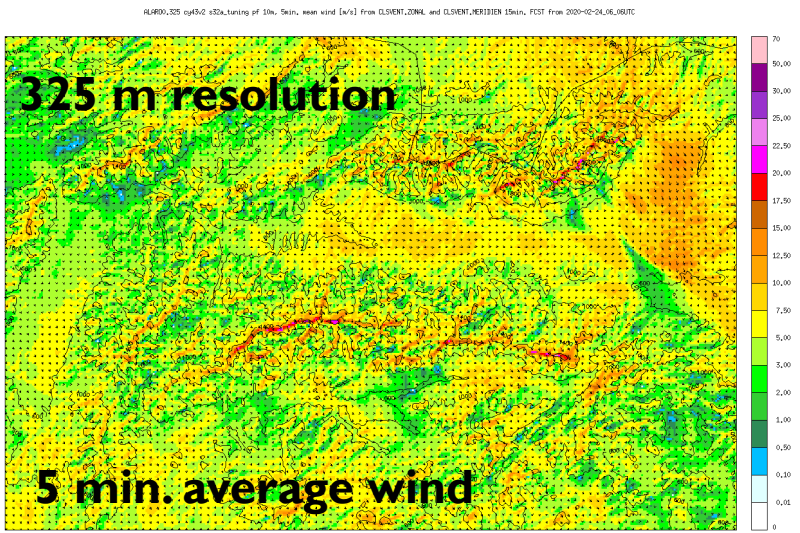
- 24 February 2020 06 UTC: strong wind over big part of Slovakia, up to 27 m/s at mountain crests (Chopok), 10-12 m/s at lowlands
- Model 10m wind forecast with 5.2 km resolution: mostly 5-15 m/s
- Dynamic adaptation at 325m resolution: > 20 m/s at crests, lowlands up to 15 m/s





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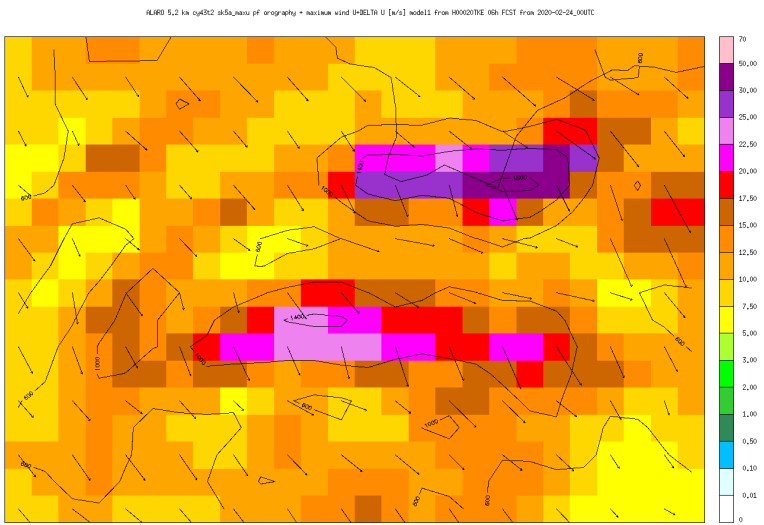
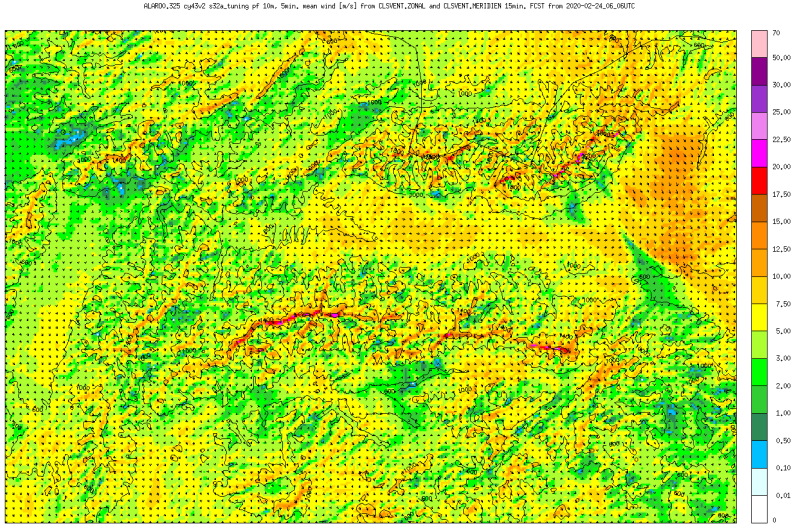
Diagnostics of subgrid maximum wind in ~5 km resolution models

- Parameterized maximum wind in the subgrid area of the 5.2 km resolution model is close to forecasts of the 325 m dynamic adaptation at mountains. However, the maximum wind at lower elevations is somewhere (e.g. Poprad valley) overestimated.
- Still experimental, to be coded
- Scale dependency, tuning needed for different horizontal resolutions of the model





Adapting the screening level diagnostics to improve AROME temperature forecasts in Alpine areas

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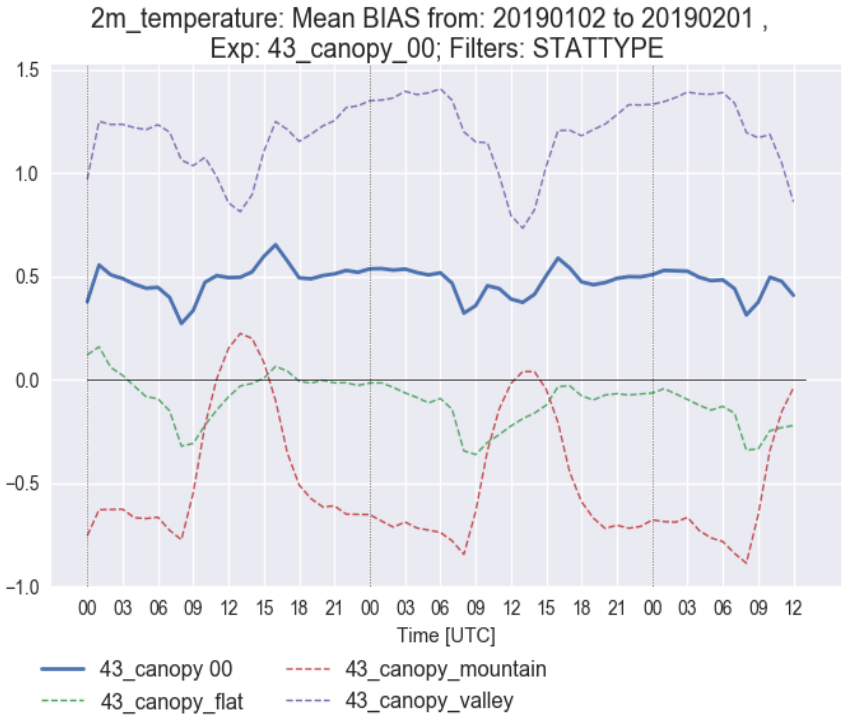
- AROME 2.5 km and 1.2 km operationally used with CANOPY scheme
- Evaluations show that the methods have different strengths and weaknesses in different weather situations
- It seems they do not work equally well for different types of locations
- The largest forecast errors for 2m temperature regularly occur during wintertime in Alpine valleys
- Introduce some orographic dependency into the current diagnostics
- Introduce another method (Dian et al, 2016) as N2M=3 within SURFEX/AROME



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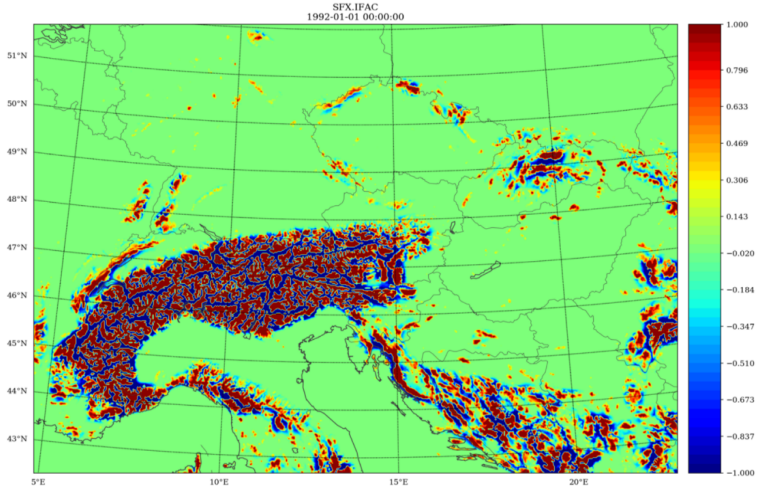
Adapting the screening level diagnostics to improve AROME temperature forecasts in Alpine areas: surface layer index

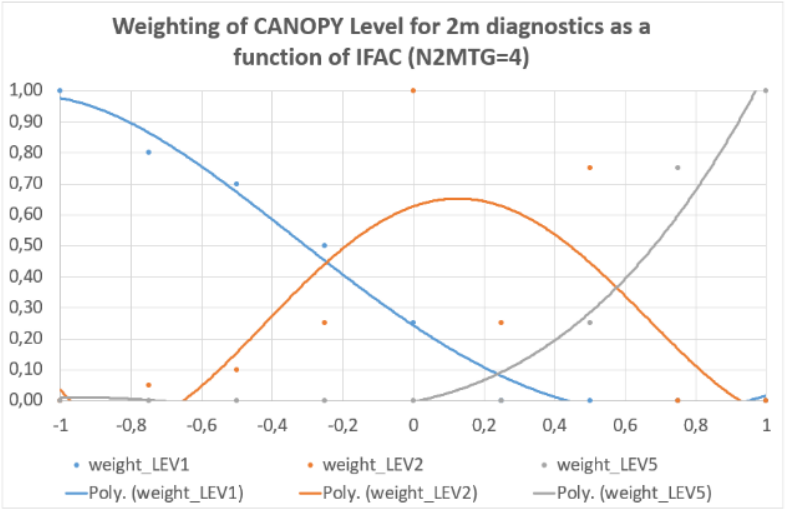
- The idea to slightly adapt the diagnostic scheme according to the topographic conditions and thus try to mitigate existing model deficiencies without major investments
- The model output 2m temperature and humidity is always based on the values at the second level from the ground. However, in certain situations and locations it turned out that it would lead to significantly better scores or reduced systematic errors when information from higher (e.g. on mountain tops) or lower (e.g. Alpine valleys) canopy levels is included instead of just using level CAN_T02 values.
- Adaptation of the "surface layer index" (aka "inversion factor" IFAC)



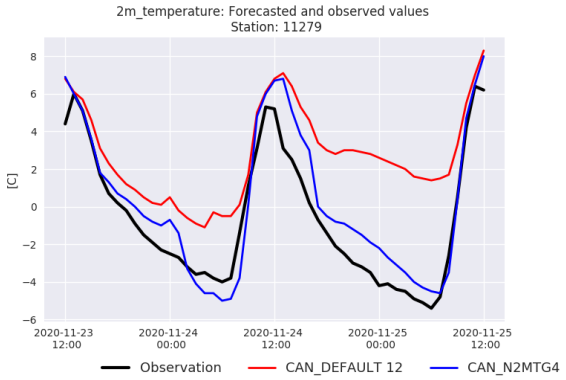
IFAC (inversion factor) for the AROME-Aut/C-LAEF domain with values varying between -1 (valley) to 1 (mountain tops) and values around 0 for flatland areas.

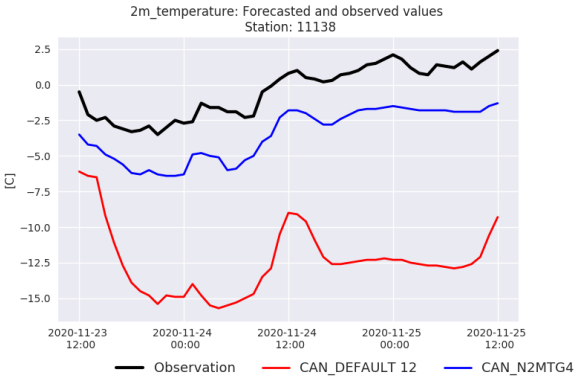
Adapting the screening level diagnostics to improve AROME temperature forecasts in Alpine areas: surface layer index

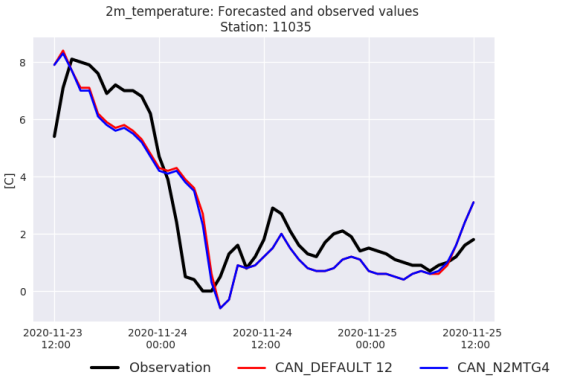
- In the next step the IFAC is used to define the weight for each canopy level for the final composition of the extracted value for temperature and humidity
- Give more weight to the higher canopy levels or free atmosphere for exposed grid points on mountain tops and more weight for lower canopy levels for grid points located in narrow Alpine valleys. In between, in flatland areas the weighting is close to the default canopy diagnostics
- .To allow a smooth transition of weights quadratic polynomial functions are used



Adapting the screening level diagnostics to improve AROME temperature forecasts in Alpine areas: surface layer index

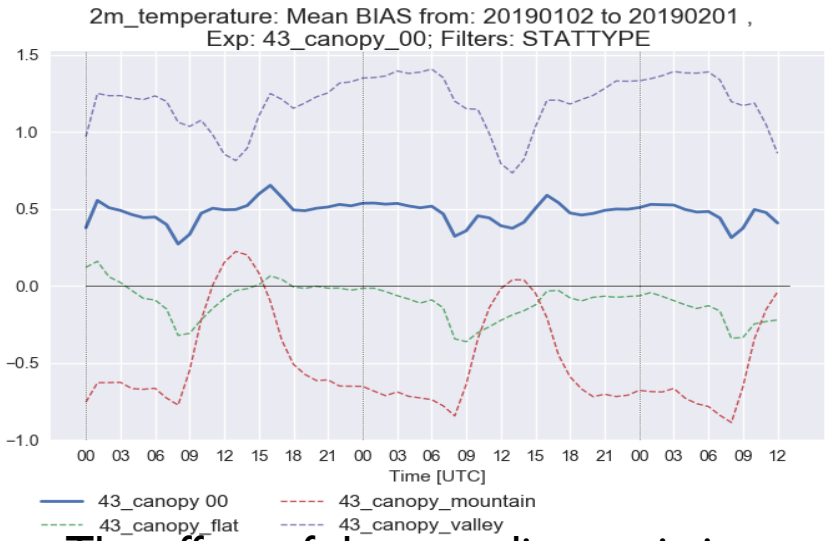


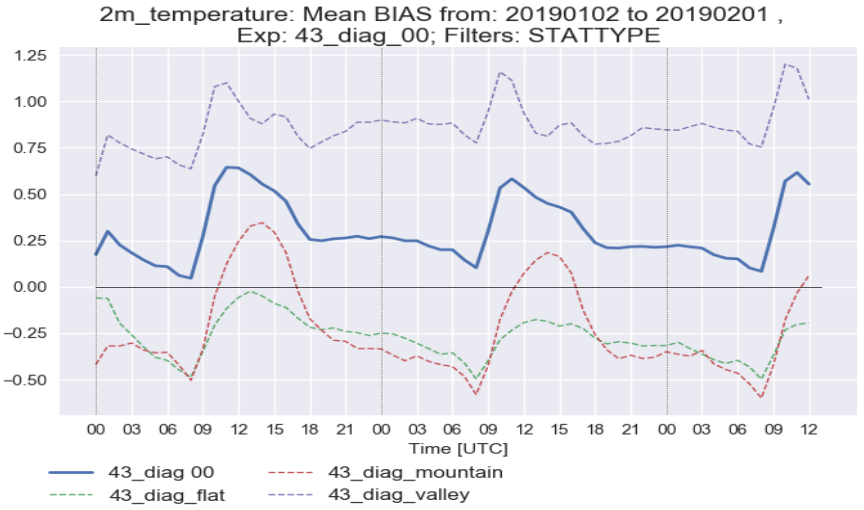




forecasts and the observed 2m temperature for a station located in a valley (left), on a mountain top (middle) and in the flatlands (right) for 23rd November 2020, 12 UTC run.

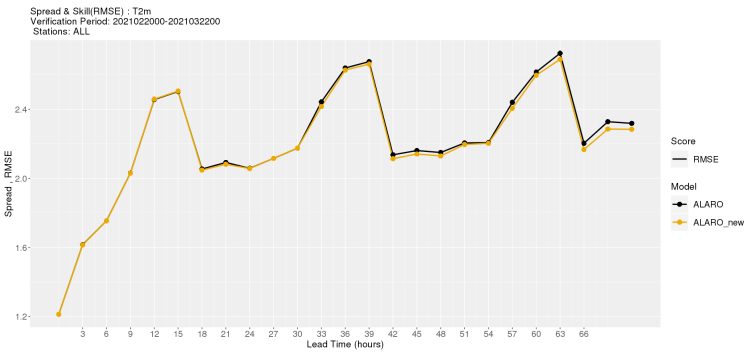
Adapting the screening level diagnostics to improve AROME temperature forecasts in Alpine areas: surface layer index



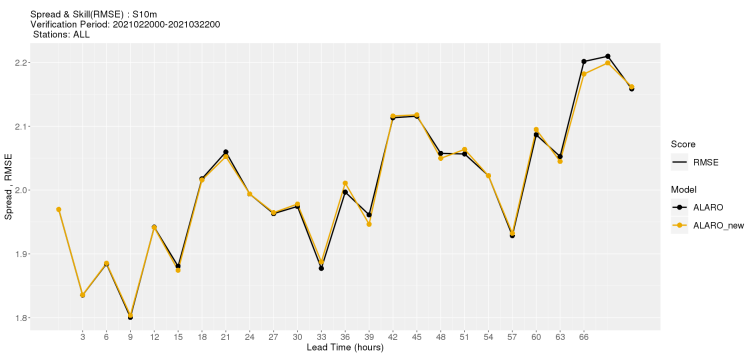


- The effect of the new diagnostic is as expected: It improves the performance for this case study in valleys and on mountain tops while it performs equally in flatland areas.
- This method can be also seen as some kind of bias correction placed within the model diagnostics to mitigate model deficiencies to resolve either shallow inversions in Alpine valleys and to ignore misplaced inversion layers on exposed grid points.

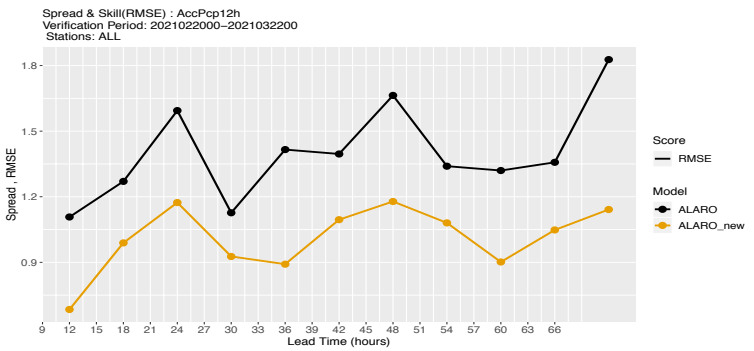
Prognostic graupel scores for 22.02.2021 – 22.03.2021



T2m



S10m



12h Precip

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.

Prognostic graupel scores for 22.02.2021 – 22.03.2021

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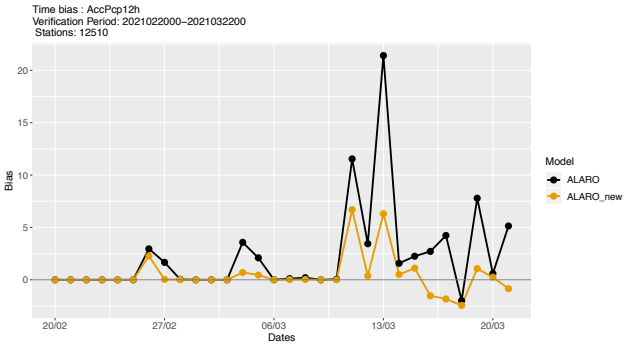
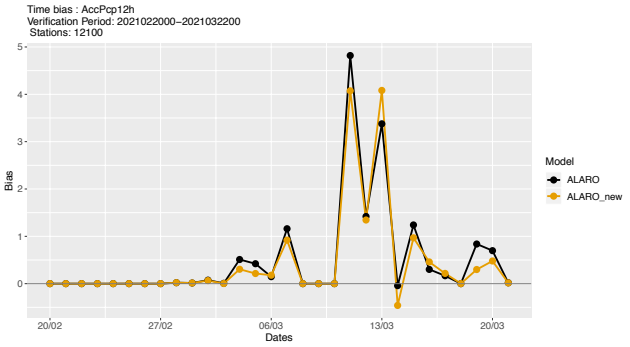
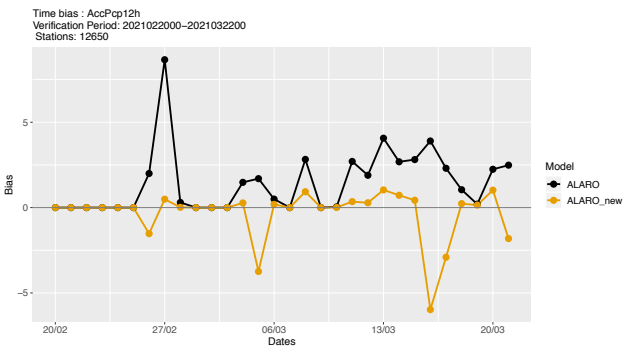
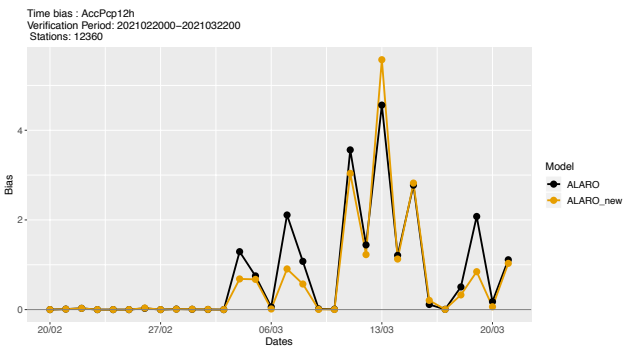
BIAS for 24 h precipitation for all dates









Mountain stations

Flatland stations

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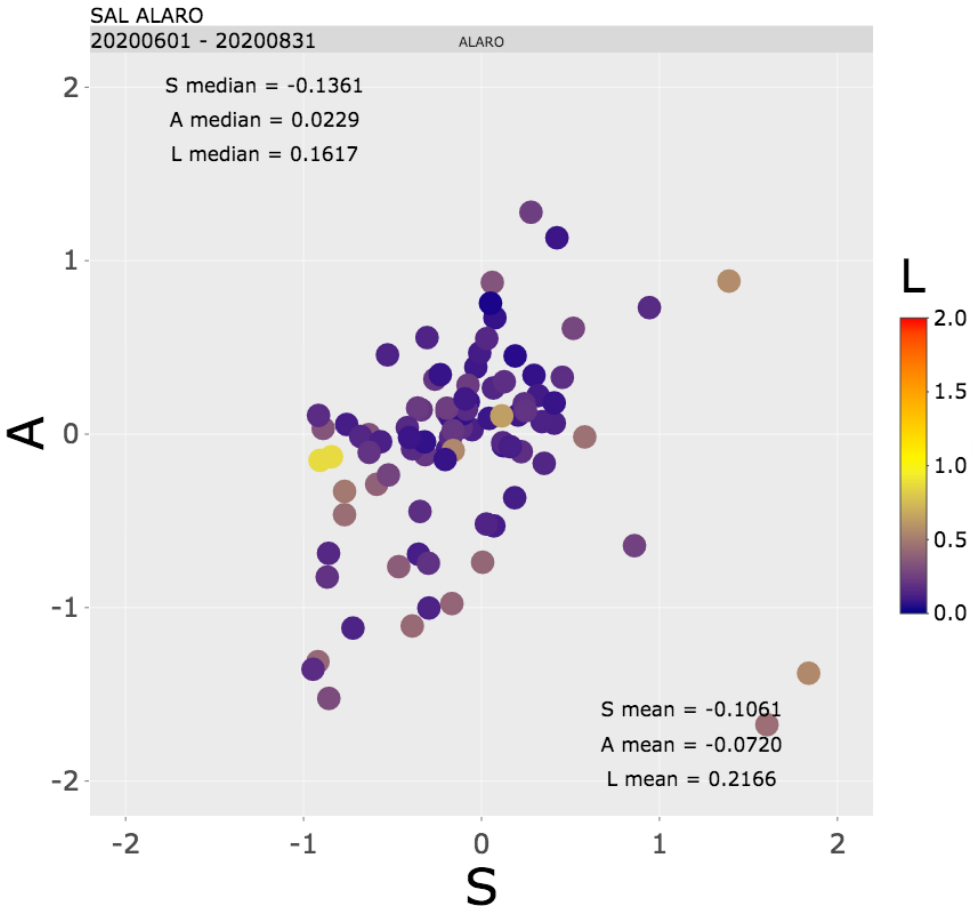
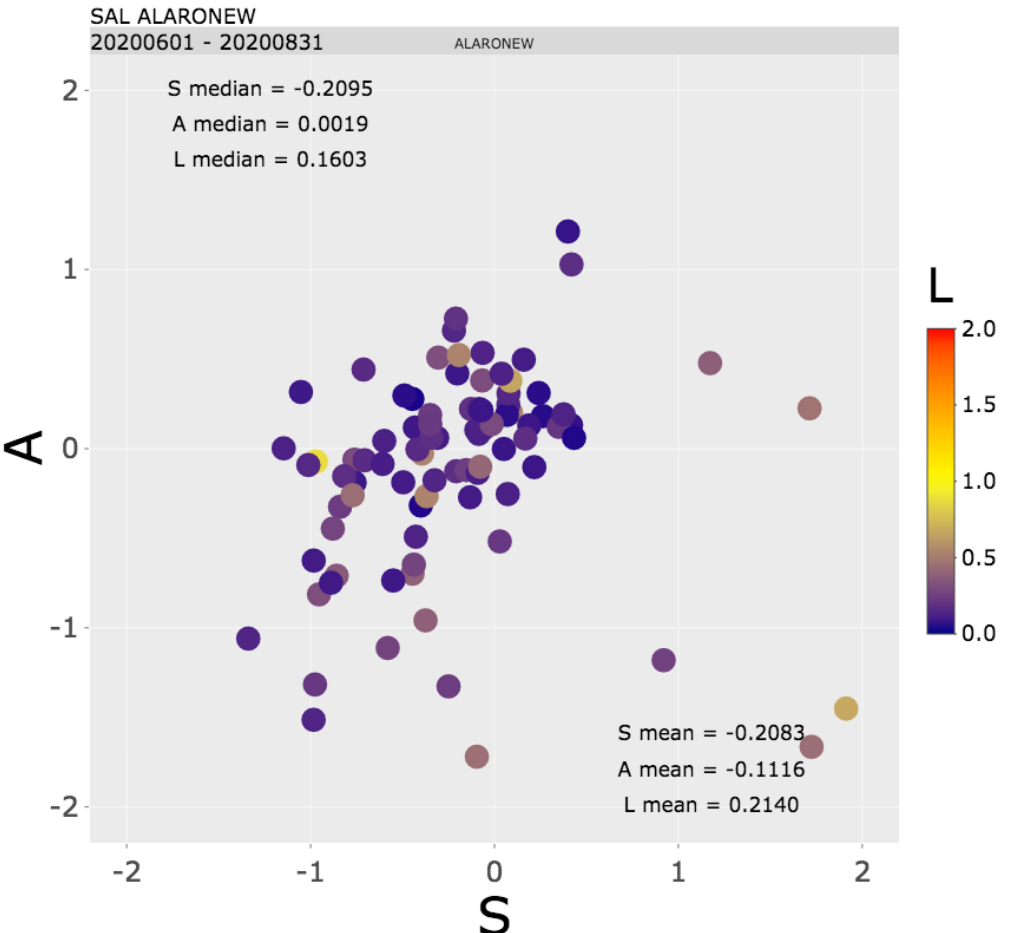
Prognostic graupel





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Thank you for your attention.

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