

*Regional Cooperation for  
Limited Area Modeling in Central Europe*



# Several surface activities in LACE

Martina Tudor on behalf of many scientists from LACE



**Czech  
Hydrometeorological  
Institute**



**HungaroMet**  
Hungarian Meteorological Service



**ARSO METEO**  
Slovenia

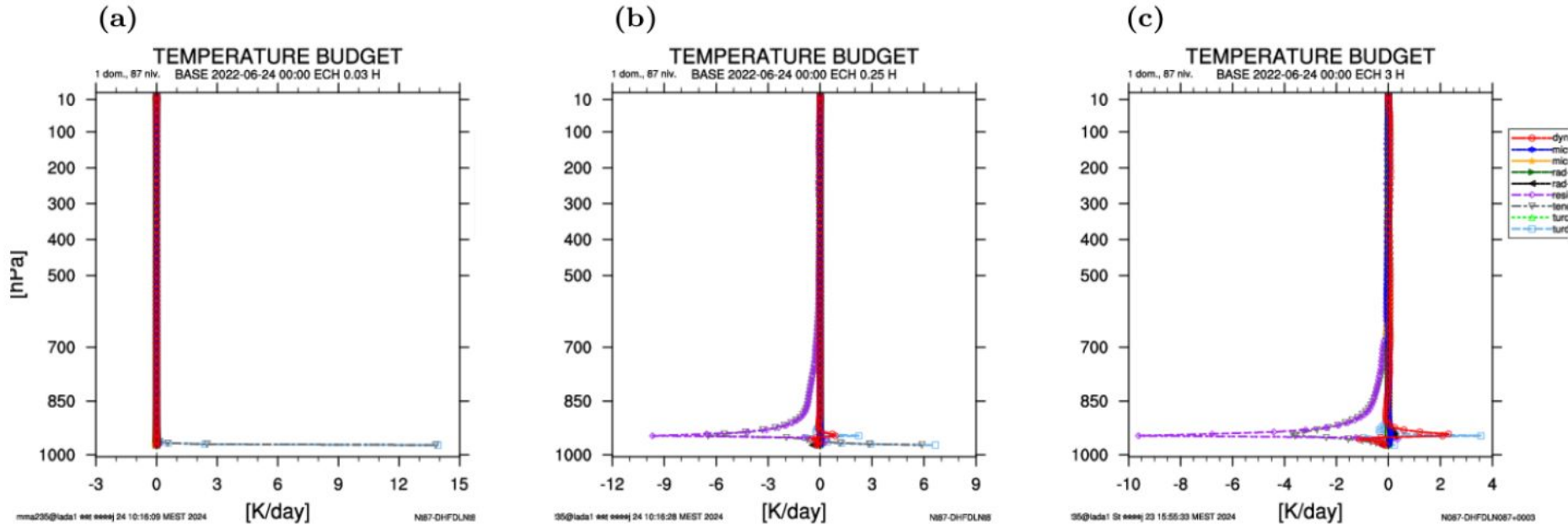
- ALARO + SURFEX few details, for more -> see the presentation of Jan Mašek

Activities according to the ACCORD WPs:

- PH7: On the interface between the surface and the atmosphere
- SU3: SURFEX: validation and development of existing components for NWP
- SU5: Assess/improve quality of surface characterization

Future: MUSC, tests in DAVAI, climate, parallel, oper ...

# On the interface between the surface and the atmosphere



Modifying the TOUCANS code to distinguish vertical levels 'seen' by dynamics and turbulence:

- Goal: a safe decrease of the lowest model level (take care of the blending height)
- Keeping the constant flux approximation
- Modifying the TOUCANS code, i.e., introducing  $KLEVTUR \leq KLEV$  (the modified code compiles but ...)

Contributors: R. Brožková (Cz), M. Hrastinski (Cr) and J. Mašek (Cz); TOTAL: 2.50 PM

There were four activities within this package:

- Debugging and testing ALARO with SURFEX (CHMI and IMGW)
- Town fraction experiments at HungaroMet
- Testing snow schemes in SURFEX (IMGW)
- Investigate a stable regime in surface and boundary layer with C-LAEF 1k)
  - Preparing an article for the ACCORD Newsletter 6 (XRIMAX and soil freezing/melting scheme)
  - Moving from ECOCLIMAP-I to ECOCLIMAP-II; problem with combined forest types at the floor of Alpine valleys

Contributors: D. Deacu (At), J. Mašek (Cz), S. Schneider (At), P. Sekuła (Pl), G. Stachura (Pl), A. Šljivić (Cz) and V. Tarjáni (Sk) and H. K. Tóth (Hu); TOTAL: 26.25 PM

Debugging of ALARO with SURFEX version 8.0+ was finalized in local CY46T1 op3sfx at CHMI; there are no crashes (performance to be improved)

The screen-level diagnostics in timestep zero was improved and TEB interfacing with TOUCANS revised; tests of urban heat island have started (need to use the building energy model)

Suspicious town fraction patterns were observed in ECOCLIMAP-II; the correction tool was developed at CHMI

A candidate for the NWP application was proposed:

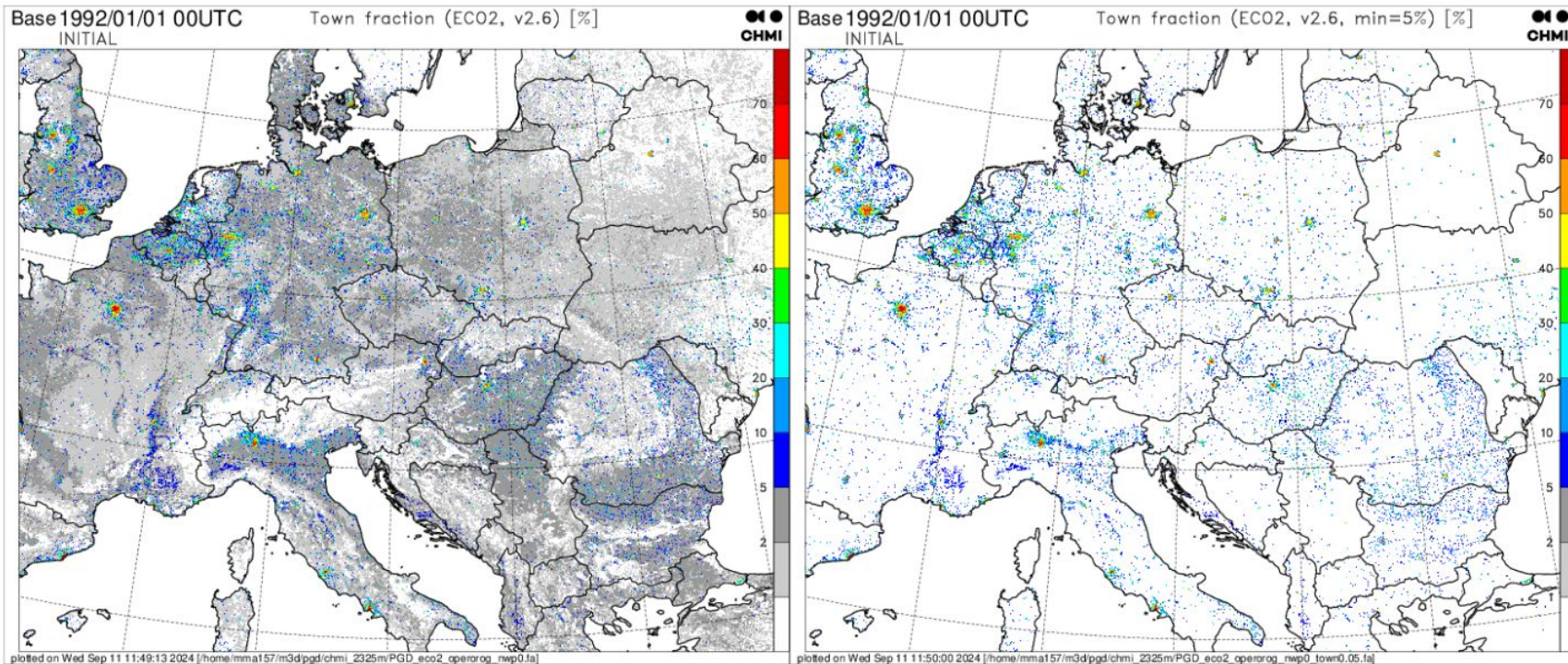
- ISBA-FR scheme; option CISBA='3-L' with 3 nature patches and without the canopy
- ECOCLIMAP-II dataset with filtered town fraction and CALBEDO='CM13' albedo option (based on satellite retrievals)
- D95 snow scheme and TEB with building energy model CCH BEM='DOE-2' (without urban canopy and garden options)
- ECUME parameterization of sea fluxes (better matches observations than the ECUME6)
- FLAKE parameterization of lakes (to be validated)

Jan Mašek, Ana Šljivić and Gabriel Stachura.

- The fixes were phased to CY49T2 (contains SURFEX 8.1+ and enables the use of ECOCLIMAP-SG);
- pull request to CY49T2 bf was made (not integrated to IAL code yet as individual commits for each fix were asked)
- After SURFEX 9.0 becomes available, the fixes will have to be passed there
- The external tool to initialize the multilayer snow scheme (ES) has been developed.
- However, as suggested by the SURFEX team, this functionality will be moved to the SURFEX-PREP.

Jan Mašek, Ana Šljivić and Gabriel Stachura.

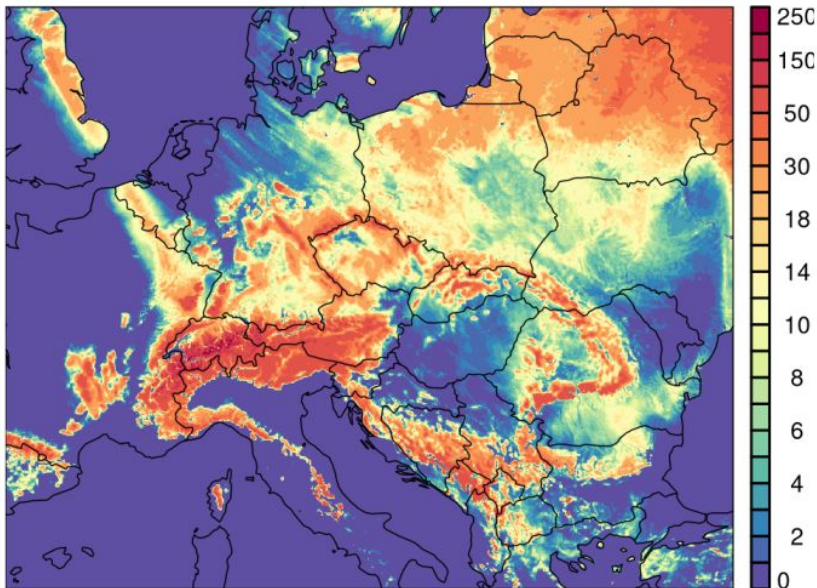
# Debugging and testing ALARO with SURFEX



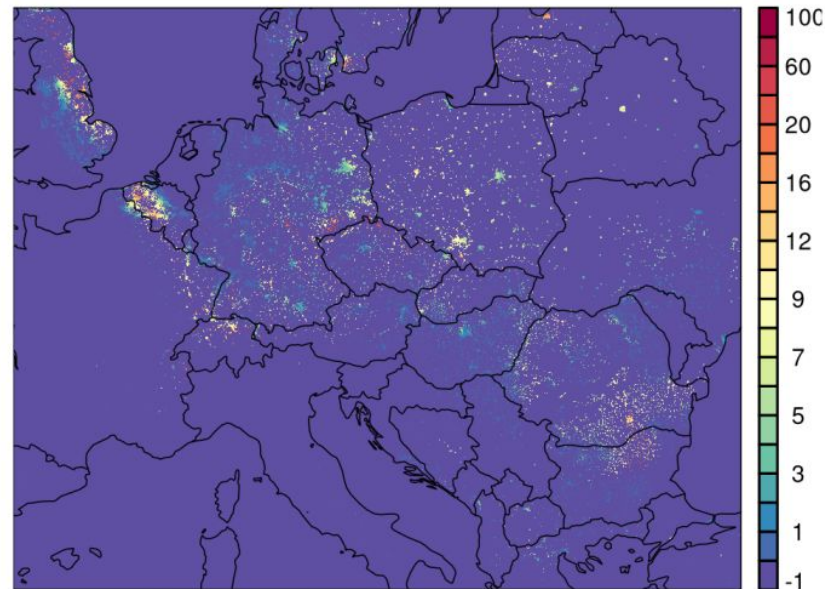
- Only the snow from nature tile is currently included in the total snow field (SURFRESERV.NEIGE); the aim was to include the contribution from urban areas
- The snow in town can occur on roofs, impervious surfaces (roads) and in garden (not accounted) Stachura&Mašek

# Debugging and testing ALARO with SURFEX

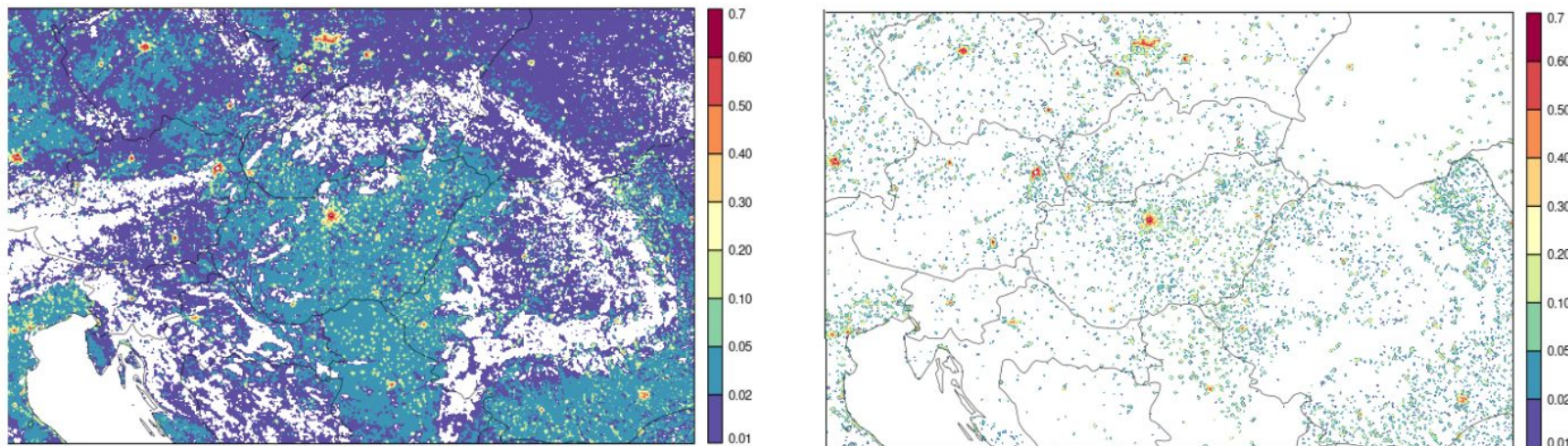
**SURFRESERV.NEIGE REF**  
2021-01-12 +72h



**SURFRESERV.NEIGE EXP - REF**  
2021-01-12 +72h

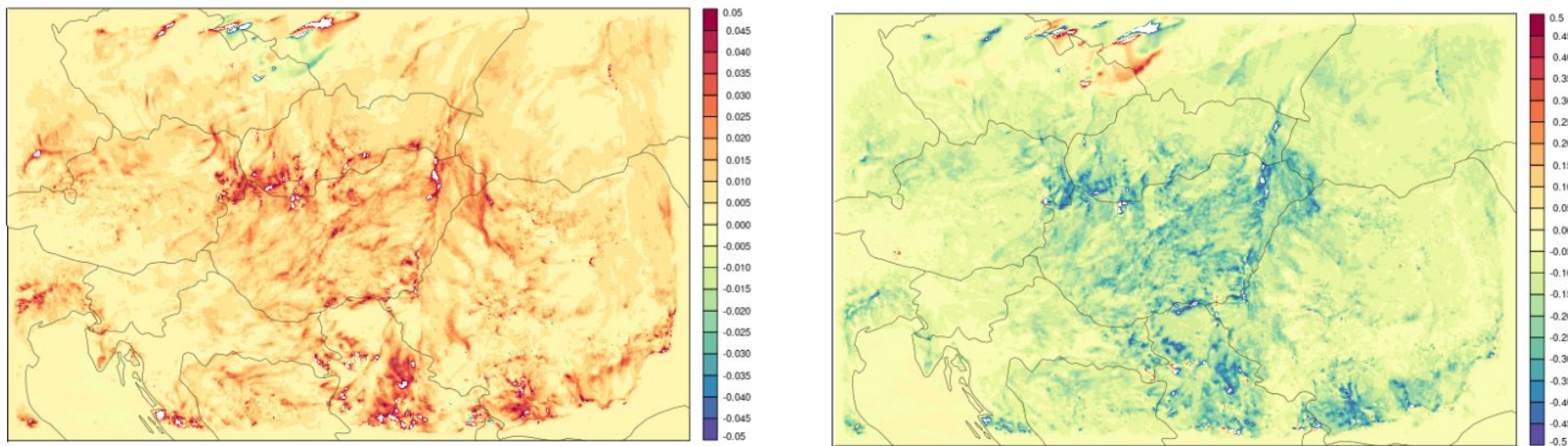


- SWE inspection raised suspicion that related values refer to town area rather than the grid-box area
- The initial results indicated erroneous snow accumulation in places with small town fraction. After correction, the differences were observed only in cities. (Gabriel Stachura, Jan Mašek)



Figures: original (left) and modified (right) town fraction

- Following the forecaster's reports on T2m warm biases in AROME/HU and AROME-EPS within AC conditions, the town fraction tests have been carried out (using the PGD tool prepared at CHMI)
- The 19 June 2024 case study with AROME/HU CY43T2 bf11, pointed to decreased overestimation of evening temperatures (above 30°C) in S/SE Hungary (night were also cooler and more humid)
- The impact diminished over a longer summer period and is currently tested within the e-suite (check HungaroMet poster?) (Helga Toth)



Figures: RH2m (left) and T2m (right) differences w.r.t the reference

- Following the forecaster's reports on T2m warm biases in AROME/HU and AROME-EPS within AC conditions, the town fraction tests have been carried out (using the PGD tool prepared at CHMI)
- The 19 June 2024 case study with AROME/HU CY43T2 bf11, pointed to decreased overestimation of evening temperatures (above 30°C) in S/SE Hungary (night were also cooler and more humid)
- The impact diminished over a longer summer period and is currently tested within the e-suite (check HungaroMet poster?)

First technical tests to run SYNOP based snow analysis in CANARI for ALARO with ISBA scheme started.

- Snow analysis is only coded for SURFEX (cy46t1) and had to be enabled for ISBA scheme. An error in the CANARI analysis flags (datum\_anflag.\*@body) has been identified and fixed on the basis of the Météo France operational branch (NFLCAN replaced by individual codes NCUT2M, NCUH2M, NCUSN, ...).
- A study on the quality control of snow measurements is underway and a flexible rejection limit for snow QC over mountains (LAOROFLEXREJSN, kindly provided by Florian Meier) is being investigated by Jáchym Ševčík, Alena Trojáková (CZ)

The CZ team continued the testing of snow analysis for ALARO CSC with the ISBA scheme. Case studies were performed to see the sensitivity to tuning parameters (horizontal and vertical length scales, observation and background errors). Additional local observations from Switzerland and Austria were collected to improve data coverage over the Alps.

Validation of TEB scheme options (see CHMI poster)

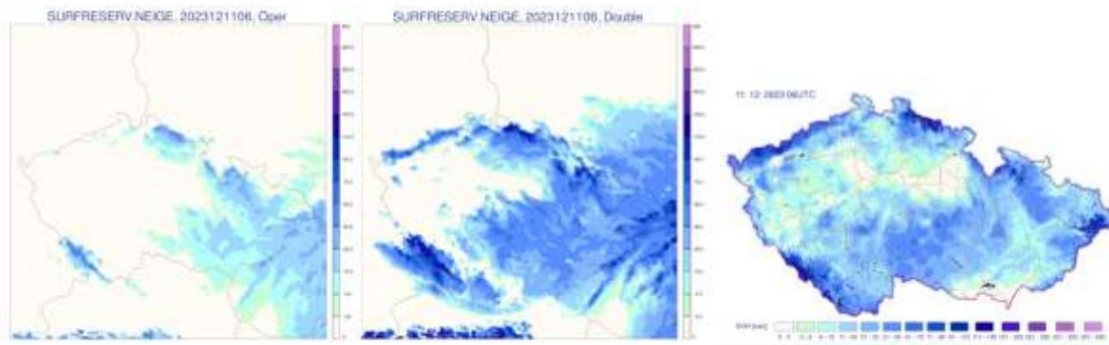


Figure: The snow water equivalent improved. Left figure snow relaxed to climatology, Middle figure relaxation switched off, Right figure observed snow water equivalent.

During preparation of a parallel suite with 3h cycling, it was found that turning off relaxation to climatology has a detrimental effect on the 2m temperature bias during autumn. To overcome this bias, the relaxation to the climatology was turned on again, but with half the coefficients of the 6-h cycle ( $RCLIMCA=0.0225$ ). Relaxation towards snow stayed switched off. This produces a more realistic snow amount as can be seen on Figure. The new 3-hour cycling strategy was launched to operations in February 2024.

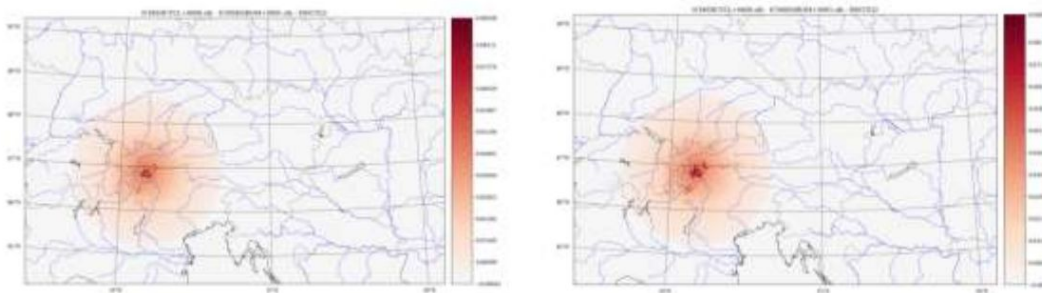


Figure: OIMAIN TG2 single observation experiment increment using one Tyrolean mountain station with standard ZCORT2/ZCORH2 (left) and modified (right). F. Meier AT

Low temperatures in the deep soil layer in CLAEF-1k over the Alpine mountains in the control run related to the wrong snow cover. It was surprising that assimilation could not correct the soil temperature, even though T2m was high and soil temperature increments are not affected by snow cover in our CANARI setting. Two reasons were detected: 1) even though TG2 values were unrealistically low (about  $-25^{\circ}\text{C}$ ), the 2 m values were rather close to observations and therefore the OIMAIN increments were small. 2) In MESCAN vertical correlation decreases rapidly (linearly within the 250 m height difference and then stays at 0.5). In complex terrain most of the stations are located in valleys while peaks are not observed well. Also the height difference between tops and valleys are rather big. This combined with MESCAN vertical structure functions leads to very small soil increments which cannot correct wrong TG2. Therefore the hardcoded values ZCORT2/ZCORH2 in catrma.F90/cacova.F90 were increased by a factor of 2. In that case the increments spread a bit further.

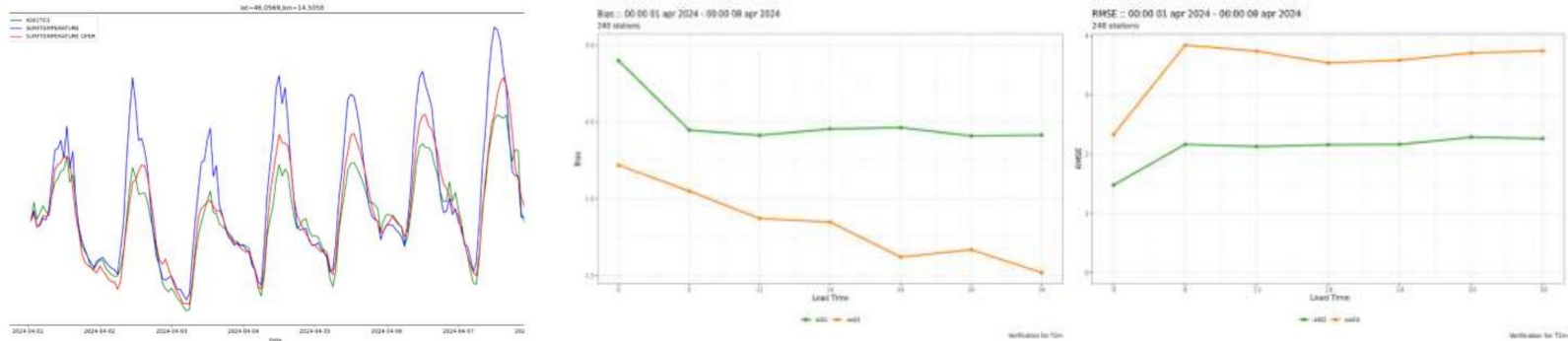


Figure: Left: Surface temperature analysis for one location. Green: Experiment X001TG1 from .sfx file. Blue: Experiment SURFTEMP from UA file. Red: Operational RUC SURFTEMP. Centre and right HARP forecast verification of T2m using synop observations (single case). Green: Operational RUC. Orange: SFX Experiment. A. Zajec, M. Ličar

The goal of the stay was to perform a full assimilation cycle in ALARO with SURFEX, which includes 3DVAR upper air assimilation, as well as assimilation of soil temperature and moisture in SURFEX-ISBA using CANARI/OI\_MAIN. An experiment for a period of 7 days was prepared on the basis of the operational RUC model with a 1 hour assimilation window and 1km domain centred around Slovenia. The experimental setup differed from the operational one only in the use of SURFEX, to allow for a meaningful evaluation of results. Initial conditions were also obtained from the operational suite, with the exception of SURFEX files. By comparison with the operational suite, the experiment shows a degradation of results. It is also worth mentioning, that during the same runs, the TG1 field in SURFEX files, and the SURFTEMP field in upper air ICMSH files show a substantial difference.

# Assimilation of satellite moisture information (SWI) within SEKF in AROME/SURFEX, impact experiments

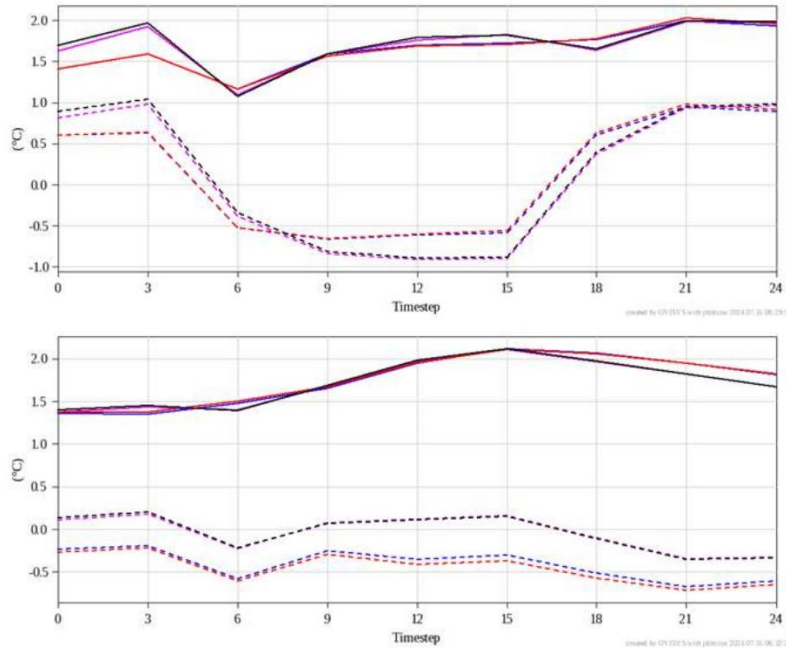


Figure: RMSE (solid) and bias (dashed) of 2-meter temperature (top) and dewpoint (bottom) for 1–31/5/2023 (only 0 UTC runs). Blue: REF, black: ASCAT-ONLY, pink: ASCAT+SYNOPSIS\_1SODA, red: ASCAT+SYNOPSIS\_2SODA.

The assimilation of ASCAT H08 Level-2 Soil Moisture product. These superficial soil moisture measurements are expressed in percentage, valid for the European region, at a horizontal resolution of 1 km. The data assimilation runs were performed with AROME cy43t2, with 2.5 km horizontal resolution and 60 vertical levels by Helga Kolláthné Tóth (HU). The test period lasted from 1 to 31 May 2023 with a 1-week spin-up. We used 3-hourly assimilation in the upper air, and SEKF of soil moisture WG1 and WG2 in the surface. We tested different values for observation and model errors in the surface assimilation to check the sensitivity of the system. The enhanced model error resulted in a huge overestimation of nighttime temperature, no bias in daytime and a big negative bias of dew point (not shown). With the increased observation error we obtained a lower overestimation of night temperature and a larger underestimation of day temperature, however almost no dewpoint bias. In the following experiments, soil temperature was also added to the control variables. In ASCAT-ONLY experiment only the ASCAT SM observations are assimilated and the control variables are the soil moistures for the superficial and root-zone layers. In ASCAT+SYNOPSIS\_1SODA both soil moisture and temperature were control variables for two layers. ASCAT+SYNOPSIS\_2SODA contains two surface data assimilation runs: 2 meter temperature and relative humidity SYNOPSIS data are first assimilated in SODA1 step (using the same observation and model errors as in the operational AROME/HU), which provides first guess for SODA2 step; ASCAT SM is assimilated in SODA2 step using the same observation and model errors as in ASCAT+SYNOPSIS\_1SODA.

Using a single SODA step, almost no added value is coming from assimilating SYNOPSIS data with respect to the run only with ASCAT data. At the same time, only minor difference is between REF and ASCAT+SYNOPSIS\_2SODA experiments, that represents a small impact of ASCAT SM assimilation compared to the SYNOPSIS data. In the continuation the extension of the CDF matching period to 2018–2023 will be tested.

- links to reports (yearly and half yearly reports and reports from stays)
  - Surface physics is in LACE Physics: <https://rclace.eu/physics>
  - Surface DA is in Data assimilation: <https://rclace.eu/data-assimilation>

Research stay reports:

TEB and snow related developments – Gabriel Stachura (2 weeks, CHMI, Prague)

TEB and snow testing – Piotr Sekuła (2 weeks, CHMI, Prague)

A. Zajec (DHMZ): Implementation and validation of OI analysis in a coupled ALARO/SURFEX system, 29. 4. – 24. 5. 2024, Ljubljana.

## ALARO+SURFEX WW and training 2-6 June 2025, CHMI, Prague, Czech Republic

- Focused on running ALARO with SURFEX
  - Will have to encompass the whole sfx+prep+forecast chain
- CY49t2 + some new developments (see the next presentation)
- Currently working on Belenos (to be ported to EC atos)
- Explore the remaining “ALARO specific” (?) problems when coupling with SURFEX
- Share experience, build knowledge, set up configs for ALARO+SURFEX runs for DEODE and possibly DAVAI test(s)

# SURFEX (Surface) switches

There is a (large) number of choices in SURFEX for physiography, general and nature, urban, sea, inland water tiles, but they are important for / used by / defined in different steps

- Three steps: Sfx, prep and forecast
  - Each step has input and output files

Running all three CSCs with the “same input files” and same executable means the same input data for the sfx step!

MUSC - uses input surface fluxes - or compute them

**Thank you for your attention!**