

*Regional Cooperation for  
Limited Area Modeling in Central Europe*



# LACE surface activities

Jan Mašek, Radmila Brožkova, Gabriel Stachura, Anamarija Zajec, Viktor Tarjani, Matjaž Ličar, Florian Meier, Clemens Wastl, Helga Kollathne Toth, Alena Trojakova ... (more on the slides)



ARSO METEO  
Slovenia

- ▶ Impact of roughness length on snow
- ▶ ALARO biases in temperature
  - ISBA in climate (spring and summer)
  - reducing soil depth and introduction of graupel improves it

Modify TOUCANS code to distinguish levels seen by turbulence

Investigating a stable regime in surface and boundary layer with C-LAEF 1k

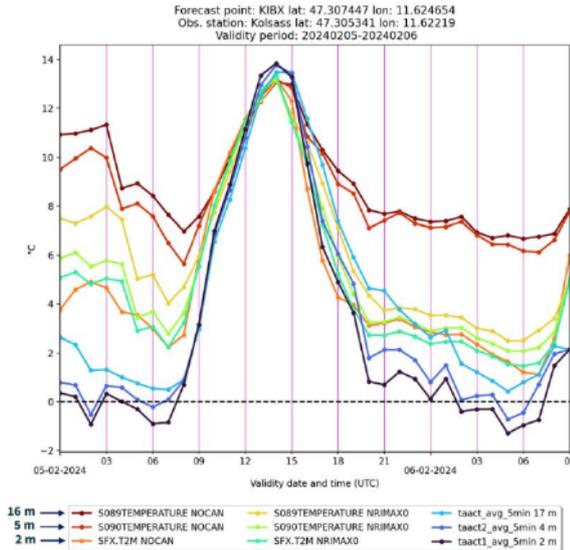
Testing ALARO with SURFEX at CHMI

Testing snow schemes in SURFEX

Investigation of numerical oscillations in the surface energy balance equation solver

# Investigating a stable regime in surface and boundary layer with C-LAEF 1k

- ▶ The aim is to reduce the nocturnal warm bias in the near-surface air temperature from C-LAEF 1k in Alpine valleys by i) reducing the  $Ri_{max}$  in computation of surf. turb. fluxes and ii) optimizing the soil freezing scheme
- ▶ The impact of reducing the  $Ri_{max}$  (XRIMAX):



**NOCAN** - control member of C-LAEF 1k (XRIMAX=0.2)

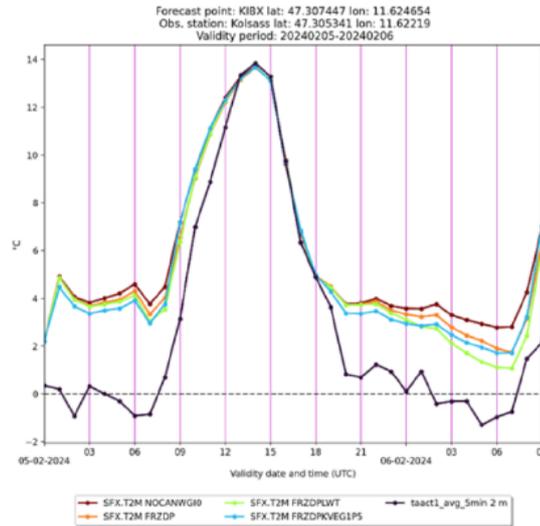
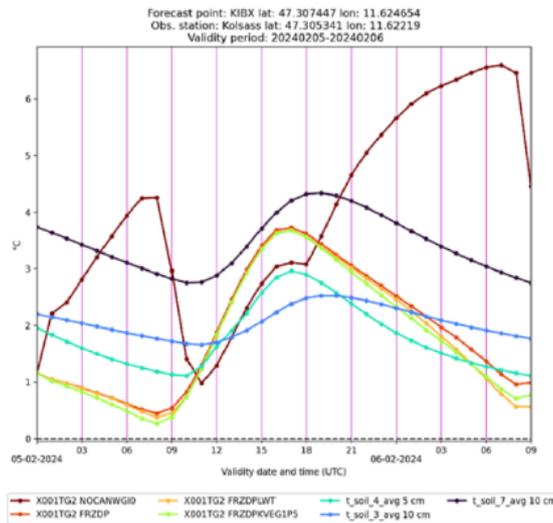
**NRIMAX0** - XRIMAX=0.0 (the largest impact!)

T2m is comparable for both exp. (differences for higher levels);  
similar results as from 3-h forecasts of the continuous DA suite

i-Box station Kolsass (T2m, T4m and T17m) vs. nearest gridpoint  
high-pressure, clear sky and weak wind conditions

# Investigating a stable regime in surface and boundary layer with C-LAEF 1k

- ▶ Testing the settings of the soil freezing scheme (large oscillations in deep soil layer temperature for the NOCANWG10 exp., driven by freezing and thawing of soil ice in the surface layer)



**NOCANWG10**; C-LAEF 1k control member settings (sub-surface layer)

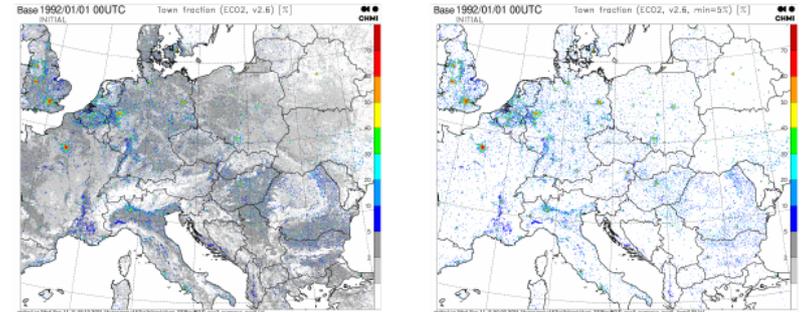
**FRZDP**; freezing/melting rates (entire deep layer)

**FRZDPLWT**; FRZDP + soil freezing characteristic curve activated

**FRZDPKVEG1P5**; FRZDP +  $K_2 = 1.5$  (in  $K_s$ , i.e., veg. insulation comp.)

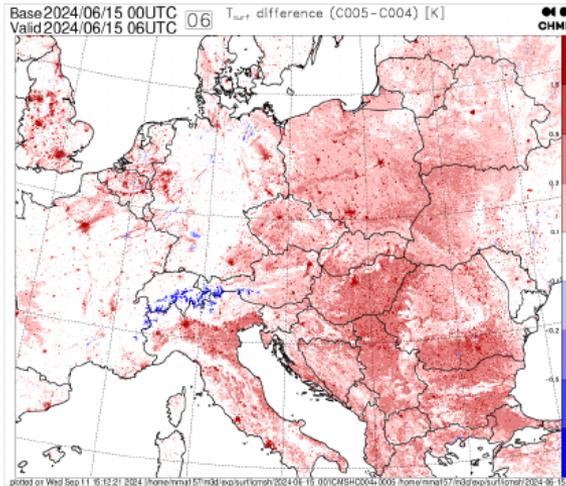
i-Box station Kolsass (T2m, T4m and T17m) vs. nearest gridpoint  
high-pressure, clear sky and weak wind conditions

- ▶ The focus was on the climate configuration with 14L diffuse ISBA, 12L explicit snow scheme, TEB and FLAKE
- ▶ Several critical bugs were found and fixed: i) wind protection in the ECUME6 scheme, ii) increased snow packing (16 → 30 bits; with ESS scheme), iii) FLAKE fix enabling safe restarts (similar to ii)) and iv) corrected canyon temperature calculation in TEB (including deactivated traffic sources).
- ▶ Further focusing on TEB:
  - ▶  $C_H$  over the roofs without using the TOUCANS stab. fun.
  - ▶  $z_{0m}/z_{0h} = 200$  (over the roofs) and 1 (over the canyon)  
TOUCANS way:  $z_{0m}/z_{0h} = 10$  (directly on the town scale)
  - ▶ Inspecting the town fraction (TF) in ECOCLIMAP-II (filtering small values)

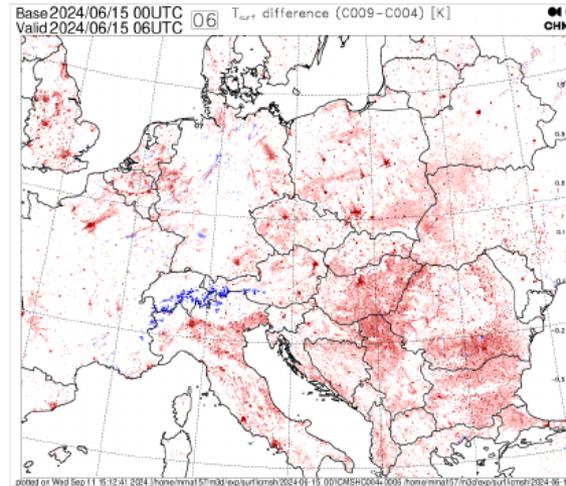


# Testing ALARO with SURFEX at CHMI

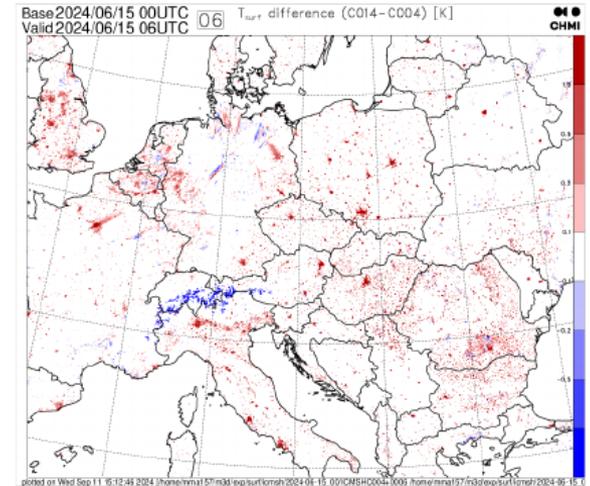
- ▶ The impact of i)  $C_H + z_{0m}/z_{0h}$  fixes and ii) the town fraction filtering (TF < 5% threshold) on surf. temperature:



reference code



$C_H + z_{0m}/z_{0h}$  fixes

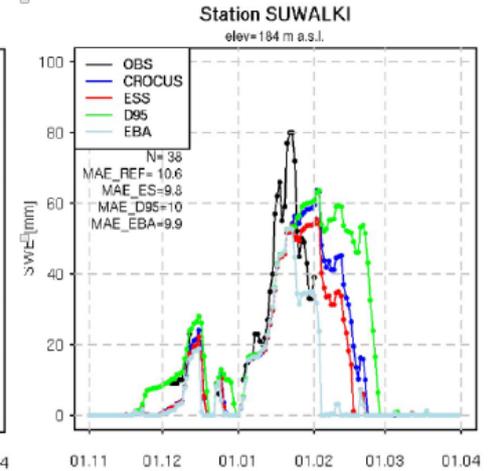
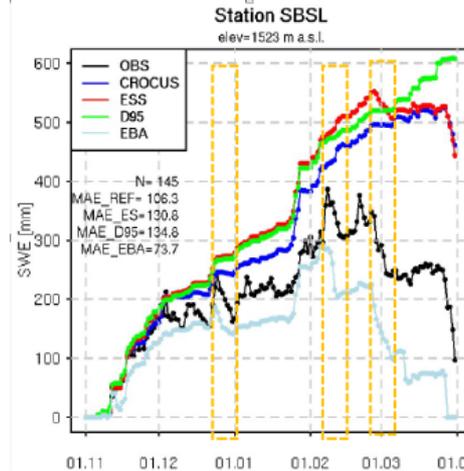
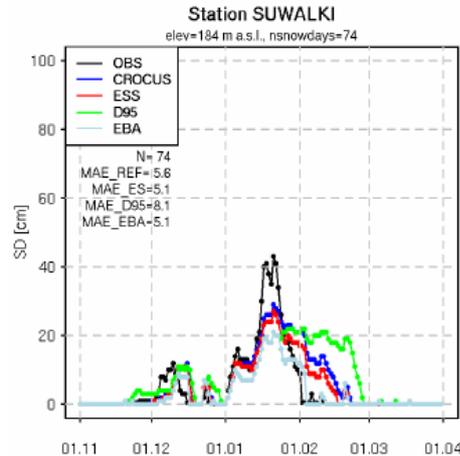
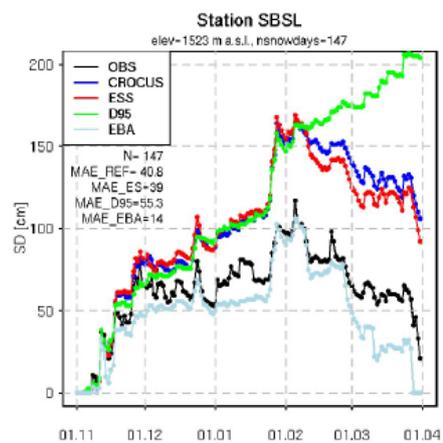


$C_H + z_{0m}/z_{0h}$  fixes + TF filtering

So far, a single nature patch was used. The goal: use 2 or 3 patches to improve the soil-snow-vegetation interact.

# Testing snow schemes in SURFEX

- ▶ Evaluating all available snow schemes in SURFEX (D95, ESS, EBA and CROCUS); forcing from the 2.5 km AROME configuration with 1-h frequency,  $\Delta t = 900s$ , 10 vert. lev. of ESS and CROCUS, 1 patch
- ▶ The longer-term evaluation for two Polish stations: i) a mountain station SBSL (in the south), and ii) a flat terrain station Souwalki (in the northeast)



Too much snow accumulation (except EBA)  
bias in temperature and precipitation

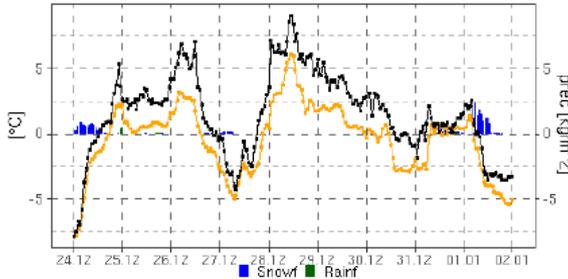
The biggest diff. between schemes during melting periods

# Testing snow schemes in SURFEX

► The focus is on the first melting period and SBSL station:

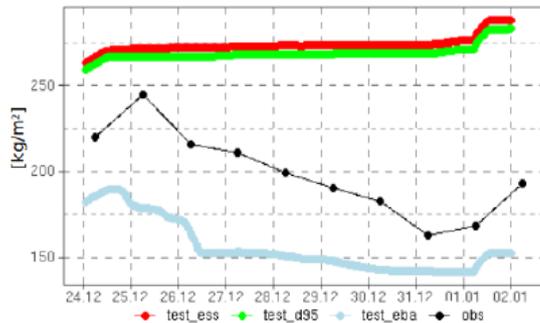
FORCING temperature and precipitation at station SBSL

model elev: 1448, real elev: 1523 [m a.s.l.]  
NATURE: 99.5%, TOWN: 0.5%



WSN\_T\_ISBA at station SBSL

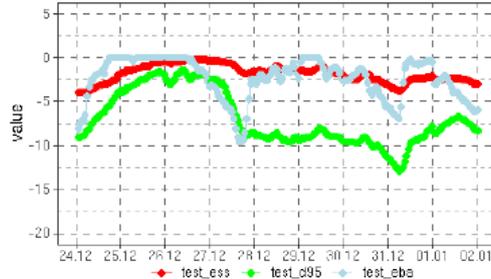
model elev: 1448, real elev: 1523 [m a.s.l.]  
NATURE: 99.5%, TOWN: 0.5%



Forcing + snow mass

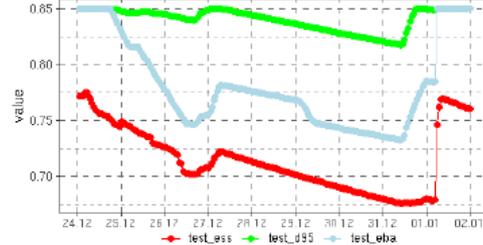
TSN\_T\_ISBA at station SBSL

model elev: 1448, real elev: 1523 [m a.s.l.]  
NATURE: 99.5%, TOWN: 0.5%



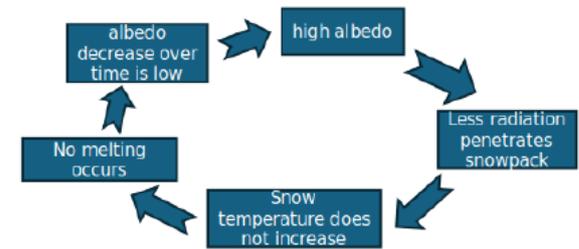
ASN\_VEGP1 at station SBSL

model elev: 1448, real elev: 1523 [m a.s.l.]  
NATURE: 99.5%, TOWN: 0.5%



Surf. temp. + albedo

1. In D95 and ESS there is no change in snow mass despite the strong warming
2. This is because  $T_{\text{snow}}$ , i.e., a composite soil-veg.-snow, cannot reach  $0^\circ\text{C}$
3.  $T_{\text{snow}}$  is strongly affected by the albedo (exponential  $\downarrow$  when melting occurs + LAI impact within EBA)
4. Self-reinforcing feedback in D95:

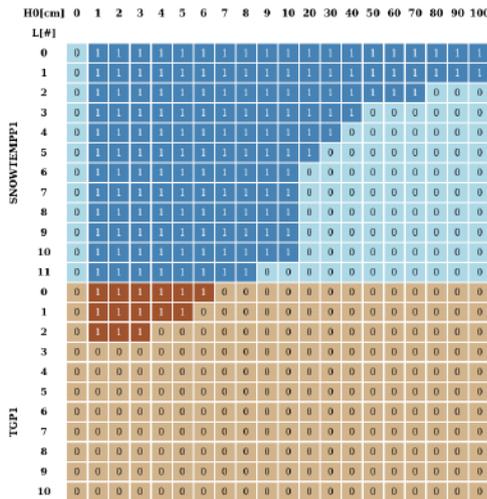


The EBA scheme performs well but ...

# Investigation of numerical oscillations in offline SURFEX

## Investigation of numerical oscillations in the surface energy balance equation solver

- ▶ Idealized offline SURFEX simulations utilizing the explicit or the Crocus snow scheme (clear sky, LW=const.,  $T=\sin(t)$ , WS=const., 12L snow + 14L DIF soil scheme,  $\Delta t = 600[s]$ )
- ▶ The oscillations are observed in multiple variables and originate from the surface layer of the snowpack, penetrating into its deeper layers and eventually to the soil

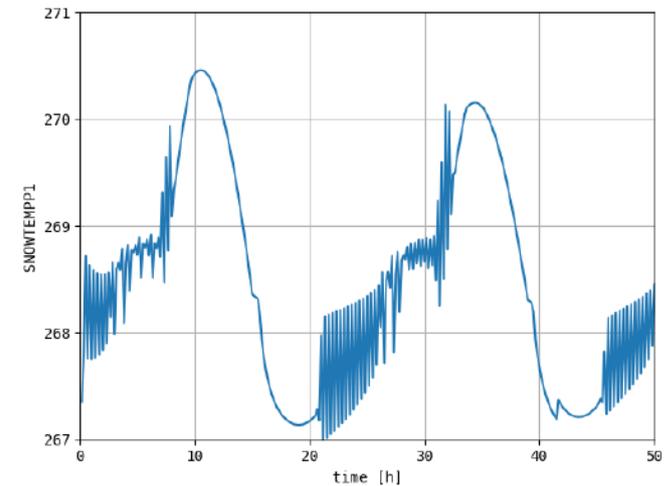


0 - no oscillations

1 - oscillations  
(at anytime)

due to num. treatment of LH and SH terms in the SEB equation

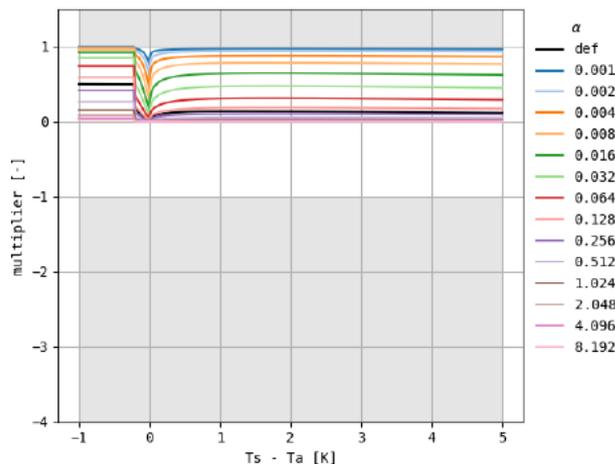
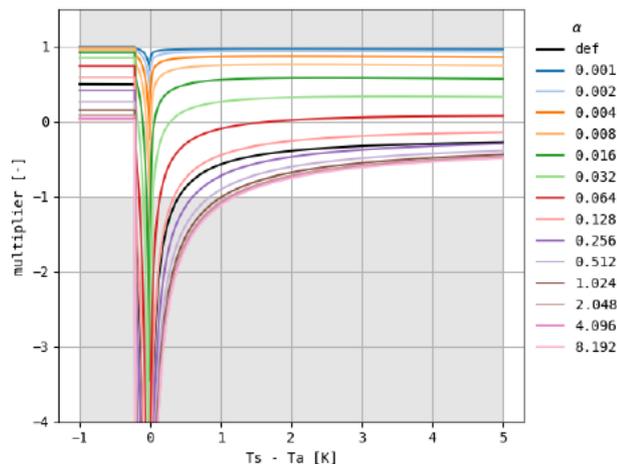
only LH component can lead to instability



# Investigation of numerical oscillations in offline SURFEX

## Investigation of numerical oscillations in surface energy balance equation numerical solver

- ▶ On a heuristic basis, a few alternatives to the original scheme are proposed, including the one based on the TL approximation (increases stability)
- ▶ The stability analysis is performed using a stand-alone program emulating the explicit snow scheme



$$\alpha = \Delta t / (\rho_s c_s \Delta z)$$

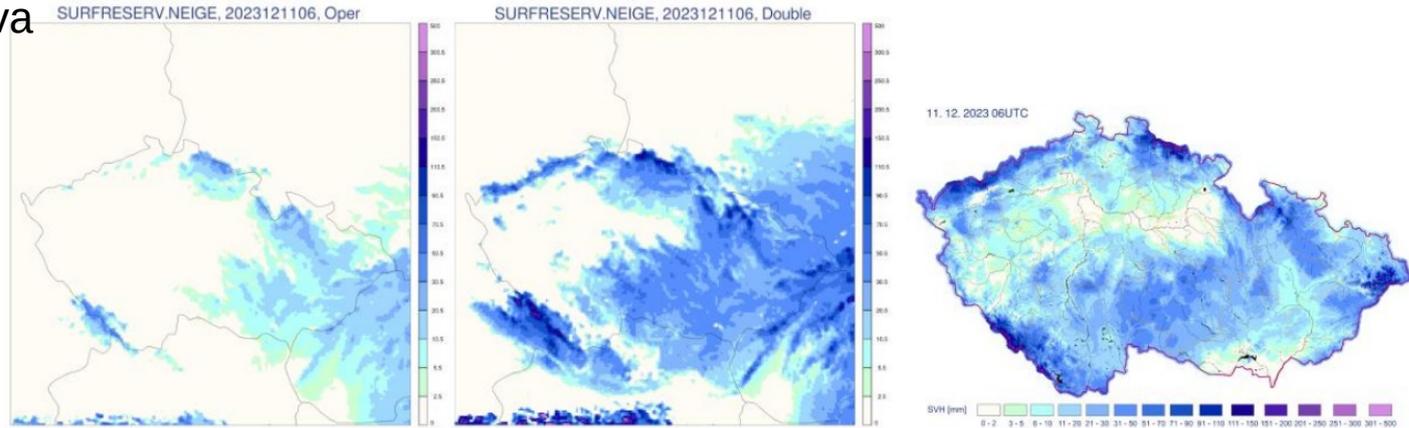
$$T_a(z = 25m)$$

num. oscillations also  
for  $\Delta t \sim 1 - 10$  s

# SYNOP based snow analysis in CANARI for ALARO with ISBA (CHMI)

- ▶ CANARI technical validation & code familiarization (master thesis of Jáchym Ševčík) snow analysis currently coded only for SURFEX enabled for ISBA, bf for CANARI analysis flag, Ongoing test of flexible rejection limit for snow QC over mountains (kindly provided by Florian Meier) – Alena Trojakova

- ▶
- ▶
- ▶
- ▶
- ▶
- ▶



- ▶ Cycling of snow in a 3-hour cycle the relaxation to the climatology was halved for soil params & switched off for snow to get more realistic snow amount – Antonin Bučanek, Radmila Brožkova, New treatment of the roughness of the vegetation covered by snow – Jan Mašek

# ALARO with SURFEX RUC (Matjaž Ličar & Anamarija Zajec)

- ▶ cycle CY43t1, 1km resolution, 1hr assimilation window
- ▶ run as ALARO ISBA oper but for SURFEX, but the scores are worse
- ▶ Surface temperature differs in atmospheric file and in SURFEX file (also different from operational RUC using ALARO with 'old' ISBA)

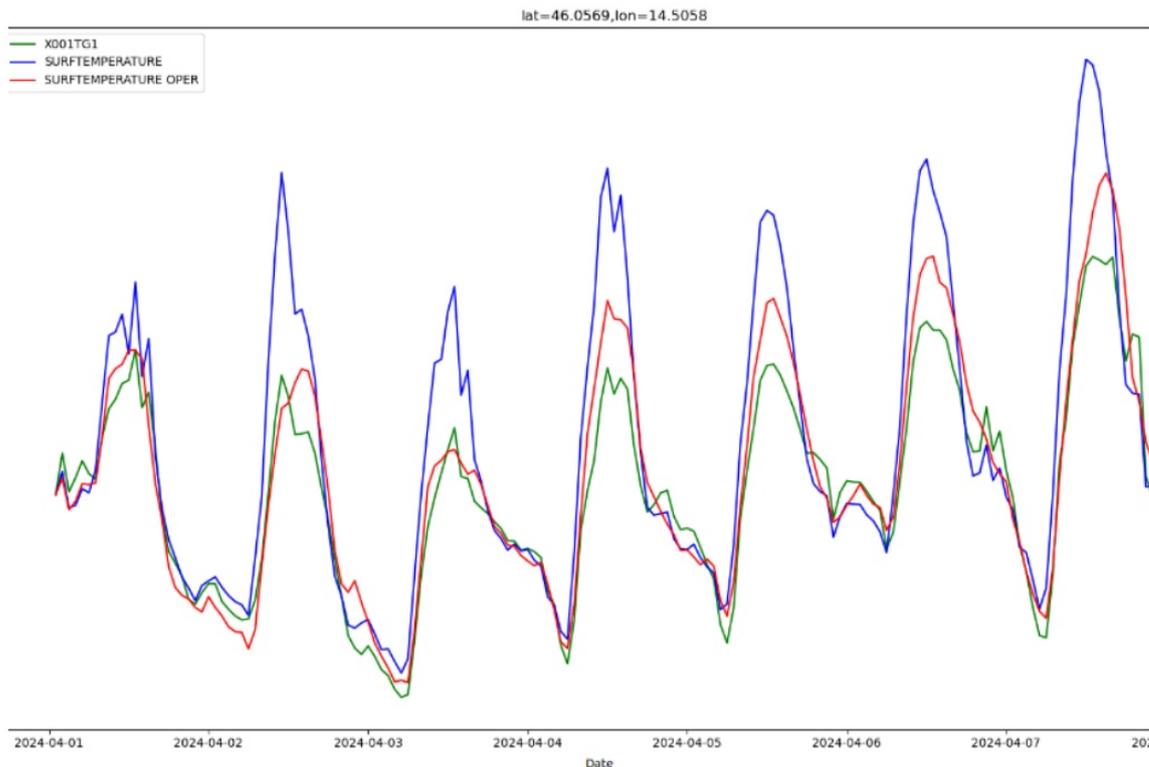


Figure 1.1.11.3: Surface temperature analysis for one location. Green: Experiment X001TG1 from .sfx file. Blue: Experiment SURFTEMP from UA file. Red: Operational RUC SURFTEMP.

# C-LAEF 1km ensemble issues (Florian Meier)

- ▶ AROME + SURFEX, too low soil temperature noticed in the Alps
- ▶ 2m temp was close to observed so (OIMAIN) increments small and value not corrected in assimilation
- ▶ (MESCAN) vertical correlation decreases with height very rapidly so measurements from valleys can't correct for wrong values on mountain tops
- ▶ correlation increased:

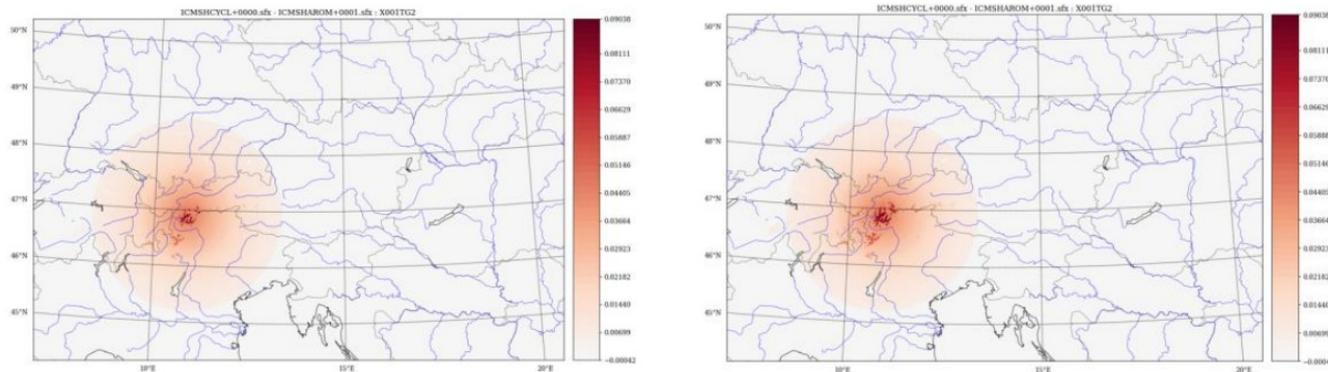
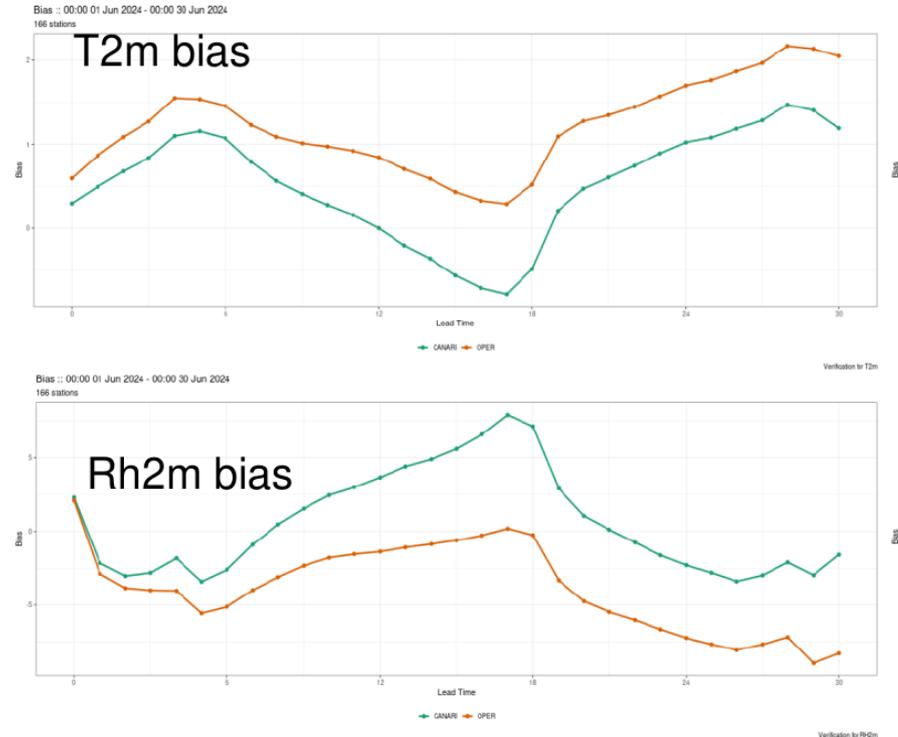


Figure 1.1.11.2: OIMAIN TG2 single observation experiment increment using one Tyrolean mountain station with standard ZCORT2/ZCORH2 (left) and modified (right).

- ▶ Several different setups of polynomes ISBA were tested
- ▶ SMU0=7 tested
- ▶ Selected setup:
  - ▶ analyse.isba02
  - ▶ SMU0=0

Alina Dumitru



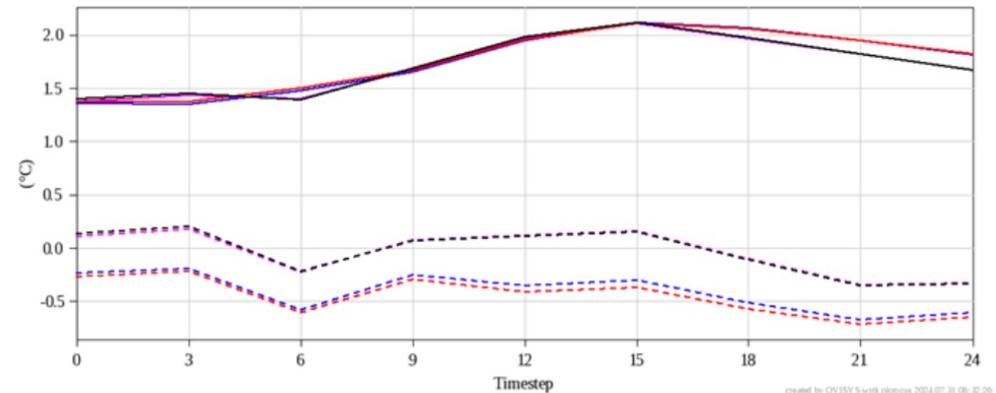
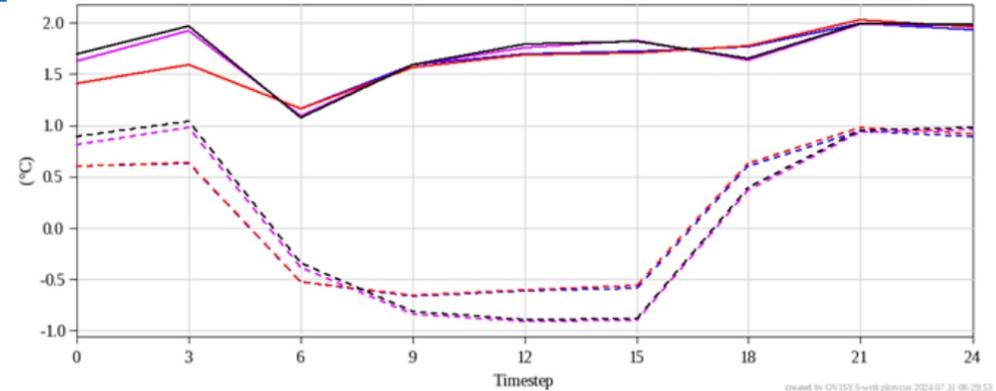
DYN. ADAPT., CANARI

# Soil moisture DA AROME HU

- ▶ ASCAT H08 Level 2 soil moisture, 1km res, Europe
- ▶ AROME HU, 2.5 km, 60 levels, 3 hourly cycling, CY43T2, SEKF for surface WG1 and WG2
- ▶ May 2023, one week spin up
- ▶ tune obs and model errors in surface DA

The enhanced model error resulted in a huge overestimation of nighttime temperature, no bias in daytime and a big negative bias of dew point.

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.



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.

- ▶ Revisiting snow impact on roughness length
- ▶ New logos of members with best format (vector preferred)

Shape of logos not distorted

- ▶ **New format 16:9** instead of 4:3 – better for newer devices
- ▶ Only one font face - Arial
- ▶ Limited number of blue colors

**First blue is the same as logo**

- ▶ **Second blue is the same as second rectangle in title slide**

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**Thank you for your attention.**

