

## Progress of ALARO with SURFEX

Ján Mašek, Filip Švábik, Radmila Brožková (CHMI)  
Martin Dian (SHMI)  
Suzana Panežić (DHMZ)



ARSO METEO  
Slovenia

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- ▶ The work on ALARO with SURFEX started back in 2015–2016 by **technical preparations**.
- ▶ Since 2017, study of roughness length problem and other issues blocking **scientifically smooth transition** from ISBA to SURFEX is ongoing.
- ▶ In 2021, **SURFEX modset** with all available developments and fixes was prepared, but it is **not yet fully validated**.
- ▶ In 2022, **additional bugs** were **found and fixed**, but the new issues arose.

## The question we are asked:

In AROME, SURFEX is operational since 2008.

It is now operational even in ARPEGE.

**What the hell are you doing, that you still do not have it working in ALARO?!**

## Our answer:

Surely, we could take SURFEX as it is, and it would work somehow. However, we need to:

1. **understand** it a bit, and
2. be sure that we **do not compromise** ALARO performance due to interfacing or incompatibility issues.

Undoubtedly, SURFEX is a complex and scientifically sound model. Unfortunately, it is a **box full of surprises.**

## Moreover:

AROME goes through some different branches of the code than we do.

There is more similarity with ARPEGE, but options like TEB are not active in the global model, while in AROME they were never used with time-step longer than 60 s.

It means that **sometimes we are entering unexplored ground.**

- ▶ Our strategy has not changed since the last ALARO-1 WD (March 2019, Bratislava).
- ▶ First we want to make a **smooth transition** from directly called ISBA to ISBA called via SURFEX.
- ▶ Having ALARO with SURFEX, we will **benefit from better physiography**.
- ▶ Then we want to **activate and validate more advanced options** (3L ISBA, ISBA-ES, TEB, FLAKE, ORORAD, ...).
- ▶ Once the target SURFEX configuration is set, **retuning of ALARO with SURFEX** can start.

- ▶ Problem of 10m wind oscillations was caused by antifibrillation treatment applied only in atmospheric model:
  - ▶ coding of antifibrillation treatment in SURFEX was not successful
  - ▶ schemes with prognostic TKE do not need it anyway
  - ▶ deactivation of antifibrillation treatment (LMULAF=F, XMULAF=0) removes the spurious oscillations
- ▶ TOUCANS stability functions on SURFEX side were fixed:
  - ▶ added missing factor C3TKEFREE
  - ▶ removed USURIC correction
- ▶ Modset for ALARO with SURFEX was prepared.



▶ Apart from **fixes**, the modset introduces some important consistency and technical **developments**:

- ▶ inclusion of orographic roughness length as in configuration E923:

$$z_0^{\text{eff}} = \sqrt{(z_0^{\text{veg}})^2 + (z_0^{\text{orog}})^2}$$

- ▶ roughness averaging without approximation  $1 + Z/z_0 \approx Z/z_0$ , enabling use of effective roughness inside SURFEX
- ▶ independent setting of thermic coefficient for different vegetation types, important for  $T_{2m}$  tuning
- ▶ scaling of the tree height and orographic roughness via namelist
- ▶ printing of all &NAM\_SURF\_ATM variables into the output listing

- ▶ Some **new SURFEX namelist variables** were introduced.

- ▶ They were all put in the namelist **&NAM\_SURF\_ATM:**

LZ0\_AVG\_EXACT ... activates unapproximated roughness averaging  
LZ0\_EFF ... adds orographic component to effective roughness  
XCTVEG(:) ... counterpart of RCTVEG(:); sets array PCV(:)  
XFACZ0 ... scaling factor for orographic roughness  
XMUL\_H\_TREE(:) ... scaling factor for the tree height  
XWNEW ... SURFEX used XWCRN also in place of XWNEW!

- ▶ Obsolete **key LALDZ0H was removed.**

- ▶ When running ALARO with SURFEX, do not forget about **compatibility keys** like **LARP\_PN** or **LDRAG\_COEF\_ARP.**

- ▶ Because of **externalization**, SURFEX must not use module variables from atmospheric model.
- ▶ One way of working—not very safe—is to **duplicate** them in the SURFEX namelist &NAM\_SURF\_ATM. For example:

```
GCISMIN    ...XCISMIN
RCTVEG(:)  ...XCTVEG(:)
LRRGUST    ...LRRGUST_ARP
UTILGUST   ...XUTILGUST
WCRIN      ...XWCRN
WNEW       ...XWNEW
```

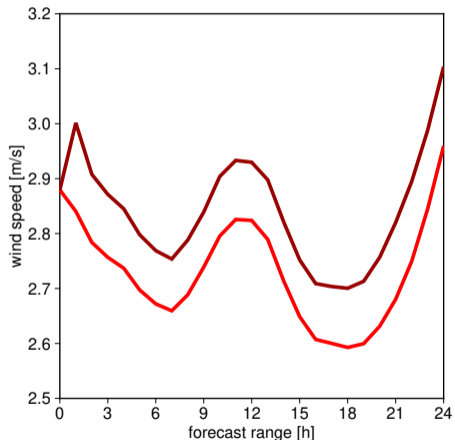
- ▶ **There are much more duplicated variables, and it is user's responsibility to set them consistently!**

- ▶ There are **additional fixes** from Radmila included in the modset:
  - ▶ added treatment of undefined roughness values in flooded areas with zero fraction, blowing up D95 snow scheme
  - ▶ added missing allocations, blowing up FULLPOS-PREP
  - ▶ added missing wind shear protection
  - ▶ safe evolution of canyon temperature and humidity
  - ▶ added moist gustiness correction
- ▶ These were **difficult to find**, but now we have a method.
- ▶ Requirement is that your FORTRAN compiler safely catches the **floating point exceptions** and produces a **traceback**.

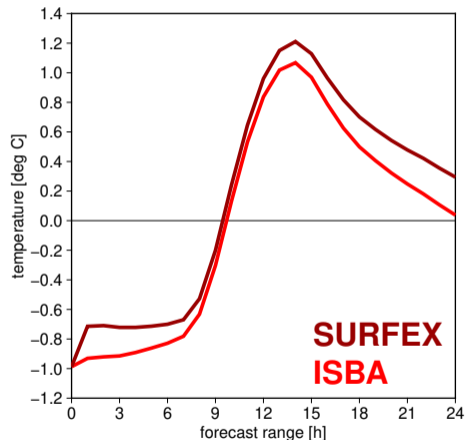
## Debugging hints from Radmila:

- ▶ compile model with traceback option
- ▶ avoid OpenMP and use minimum number of MPI processes
- ▶ activate runtime catching of floating point exceptions
- ▶ determine timestep and line where the model crashes
- ▶ at critical timestep, add writes around the problematic line
- ▶ recompile model and rerun it with NOUTPUT=2, so that every MPI process creates its NODE file
- ▶ check for NaN values, analyze how they were produced

## Lowest model level wind speed



## Lowest model level temperature



- ▶ SURFEX is a **very complex code** with many options. We are using only a **small subset** of them.
- ▶ Trying **new option** can bring surprises, it is good to **check the code** implementation when in doubts.
- ▶ **Technical aspects** like dataflow or interfacing with NWP model are **not covered by SURFEX documentation**.
- ▶ Fortunately, both **SURFEX support and GMAP are willing to help** with encountered problems.
- ▶ Advice is not always readily available, especially when we enter **nobody's land**.

- ▶ So far we worked with **cy43t2**, containing **SURFEX v8.0+**.
- ▶ It restricts our physiography choice to ECOCLIMAP I and II.
- ▶ Despite being older, **ECOCLIMAP I** dataset is still used in operational AROME and ARPEGE.
- ▶ In ALARO we decided for more recent **ECOCLIMAP II** dataset, which **lacks the global version**, however.
- ▶ It will be strategic to go for **ECOCLIMAP SG**, implemented since **SURFEX v8.1+**.



We dearly need a NWP SURFEX expertise, building it slowly and in pain. :-)

Once the day will come when ALARO with SURFEX will work as required. Then, our life will be nice again. :-)



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**Thank you for your attention.**



**ARSO METEO  
Slovenia**