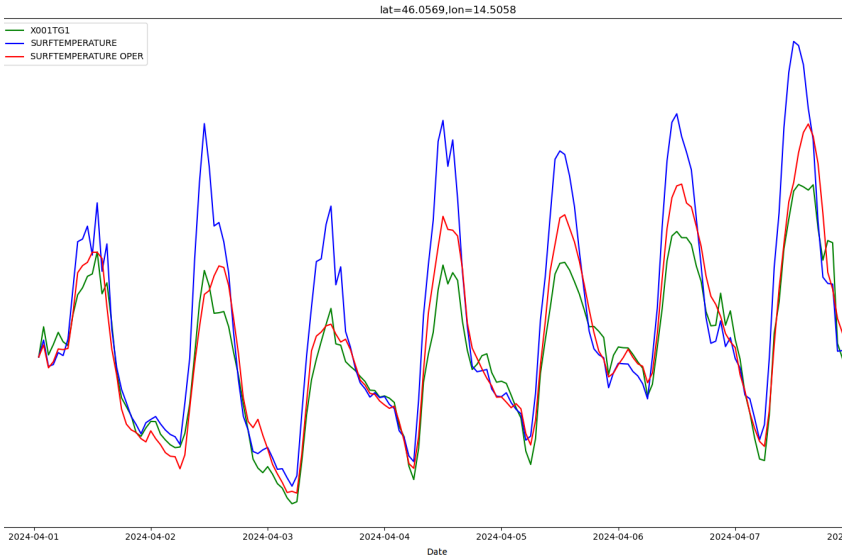
Regional Cooperation for Limited Area Modeling in Central Europe

LACE nwp central europe

Implementation and validation of OI analysis in a coupled ALARO/SURFEX system



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1 Introduction

During this research stay the aim was to produce a short cycled experiment in ALARO coupled with SURFEX and compare evolution of surface fields (SURFEX with ISBA). A one week run with ALARO/SURFEX was performed, and the results were compared to the operational ALARO. The configuration used was based on cy43t2 with a horizontal resolution of 1 km and a domain of 589x589 points. We used 1 h RUC. The domain is shown on Figure 1. The first guess for start of experiment was taken from the operational model. A dynamic adaptation (preplbc) was made for the .sfx file from the ELSCF file, after which the upper air and SURFEX fields were cycled.

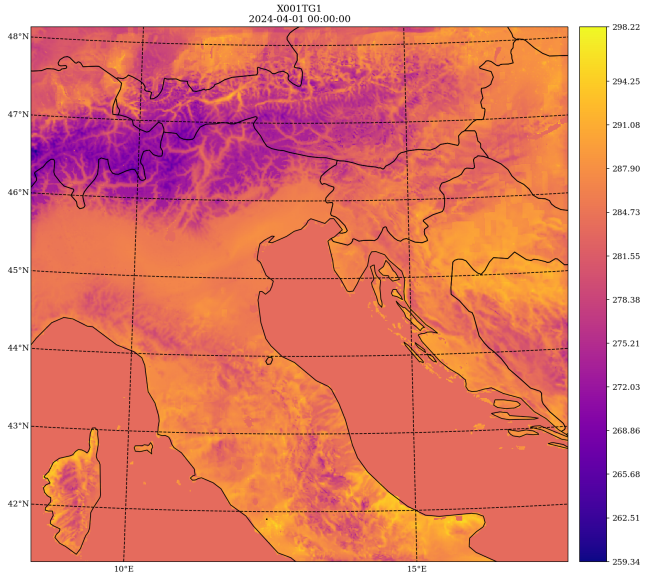

Figure 1: Representation of domain at 1.3 km horizontal resolution

2 Running Data Assimilation SURFEX inline with ALARO

On Figure 2, we can see the ecFlow suite with all tasks. Firstly, we prepare the LBC files. Then, we have the analysis, which includes surface and 3D VAR tasks. In the surface task, the canari task is important for SURFEX, where we perform the analysis in SURFEX (using OI-MAIN), which required us to modify the namelist.
Changes made in namelist:
• aldnml_001_cyinit_assim_SI13_87:
-NAERAD: NSW=1, !NMCICA=0, !NRADFR=1
-NAMARPHY: CCOUPLING='I', LMSE=.TRUE.
-NAMCT0: LCALLSFX=.T., NFRSFXHIS=60, !NPOSTS(0)=0
-NAMCT1: N1SFXHIS=1
-NAMFA: NVGRIB=2, NVERBOSE=2
-NAMOPH: LINC=.TRUE.
-NAMPARAR: NSWB_MNH=1
-NAMSFXCMP: CFLDNAME(1)='??????????????', NBBITS(1)=16
• aldnml_canari_SI13:

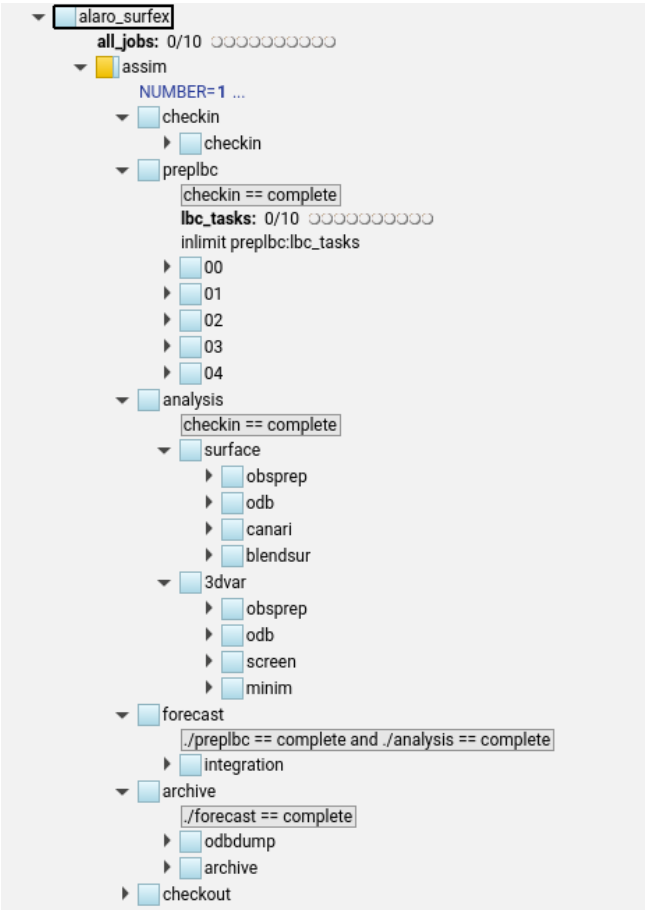

Figure 2: ecFlow suite

-NACTEX: LAEICS=.F., LAEICS_SX=.T.
-NAMFA: NBITCS=-1, NBITPG=-1, NSTRON=-1, NVGRIB=2
-NAMSFXCMP: CFLDNAME(1)='??????????????', NBBITS(1)=24
• aldnml_ee927_SI13_87:
-NAERAD: NSW=1
-NAMSFXCMP: CFLDNAME(1)='??????????????', NBBITS(1)=24
Important namelist for surfex are EXSEG1_canari.nam for canari, EXSEG1.nam for integration and PRE_REAL1.nam for PGD.

The ICMSHANALINIT.sfx is the guess, and the analysis is done in ICMSHANAL+0000.sfx. However, integration does not work with this file due to some fields. The reason is unknown at this stage. We receive wrong SFTX.SST field in ICMSHANAL+0000.sfx (Figure 3), but this is not the only issue.

After one time step it leads to a segmentation fault:

Source
mpl_waitany_mod.F90
385 slcomm.F90
187 slcomm.F90
259 call_sl.F90
91 call_sl_stack.F90
583 gp_model.F90
71 gp_model_stack.F90
503 scan2m.F90
313 stepo.F90
1207 cnt4.F90
152 cnt3.F90
109 cnt2.F90
125 cnt1.F90
165 cnt0.F90
148 master.F90

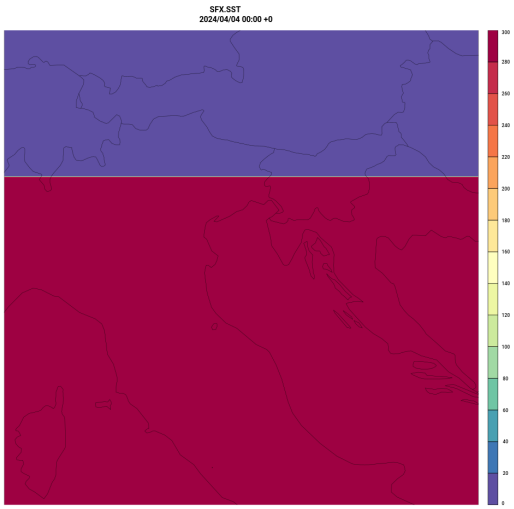

Figure 3: SFX.SST in ICMSHANAL+0000.sfx

The issues are not reproducible, a segmentation fault occurs after different time steps for different cases, and possibly in other parts of the code as well.
There are NaNs appearing in surfex/SURFEX/drag.F90 when PPS and PQA variables are read. Replacing SFX.SST with the SST field from PFE927SI13+0000.sfx using epygram produces the same problem. To resolve this, we rewrite the fields from ICMSHANAL+0000.sfx into PFE927SI13+0000.sfx, with which integration works, using the copy_to_fp.py script. Replacing the following ISBA fields: "SFX.TS_WATER", "X001TG1", "X001TG2", "X001WG1", "X001WG2", "X001WG3", "X001WGI1", "X001WGI2", "X001WSN_VEG1", "X001RSN_VEG1", "X001ASN_VEG" in PFE927SI13+0000.sfx with the fields from ICMSHANAL+0000.sfx once canari concludes resolves the issue.

2.1 Modifications in scripts

There where made some changes in scripts for canari, integration and copy_to_fp.py. On Figure 4 are shown modifications in script canari and differences before (left) and after (right).

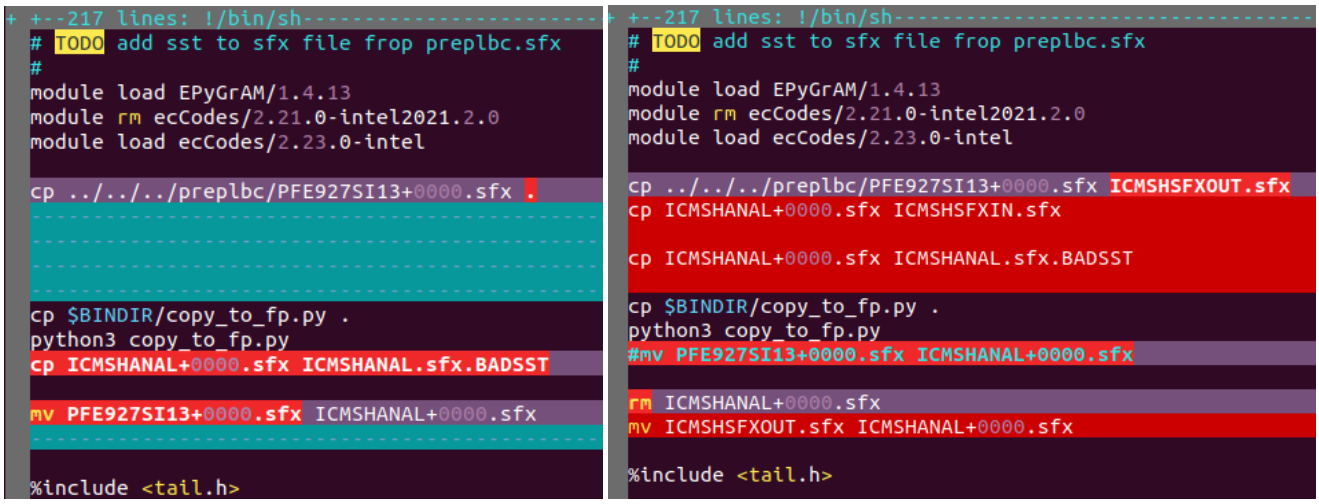

Figure 4: Modifications in script for canari before (left) and after (right) changes

On Figure 5 are shown changes in scripts for integration. On Figure 6 is shown copy_to_fp.py

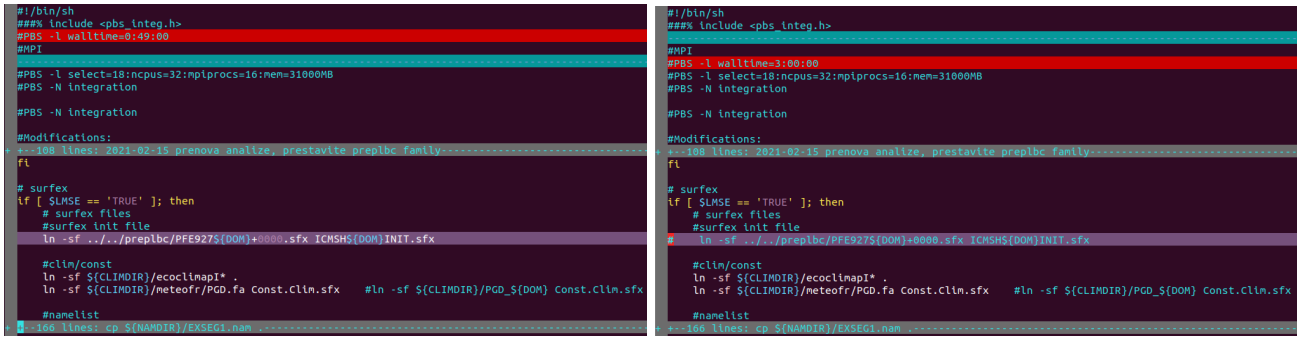

Figure 5: Modification in scripts for integration before (left) and after (right) changes

script where fields are reduced due to errors because fields where not in input file ICMSHSFX-INIT.sfx.

```python
import epygram as ep

if __name__ == '__main__':

    #can_file = 'ICMSHANAL+0000.sfx'
    #out_file = 'PFE927SI13+0000.sfx'

    can_file = 'ICMSHSFXIN.sfx'
    out_file = 'ICMSHSFXOUT.sfx'

    r_out = ep.formats.resource(out_file, 'a',fmt='FA')
    r_can = ep.formats.resource(can_file, 'r',fmt='FA')

    #fields = ["SFX.Z0SEA",       "SFX.SSS",         "SFX.SEA_SBL_Z01", #SFX.SST,

    fields = ["SFX.TS_WATER", "X001TG1", "X001TG2", "X001WG1", "X001WG2", "X001WG3",
              "X001WGI1", "X001WGI2", "X001WSN_VEG1", "X001RSN_VEG1", "X001ASN_VEG"]

             #"SFX.SSS",          "SFX.SEA_SBL_Z01", #SFX.SST,
             # "SFX.SEA_SBL_Z02", "SFX.SEA_SBL_Z03", "SFX.SEA_SBL_Z04", "SFX.SEA_SBL_Z05",
             #"SFX.SEA_SBL_Z06", "SFX.TS_WATER",     "SFX.Z0WATER",      "X001TG1",
             # "X001WGI1",        "X001WGI2",        #"X001WR",          "X001WSN_VEG1",
              #"X001RSN_VEG1",    "X001ASN_VEG",     "X001PATCH",        "SFX.TSRAD_NAT",
             # "X001RESA",        "SFX.TROOF1",      "SFX.TROOF2",       "SFX.TROOF3",
             # "SFX.TROOF4",      "SFX.TROOF5",      "SFX.WS_ROOF",      "SFX.TROAD1",
              #"SFX.TROAD2",      "SFX.TROAD3",      "SFX.TROAD4",       "SFX.TROAD5",
              #"SFX.WS_ROAD",     "SFX.TWALL1",      "SFX.TWALL2",       "SFX.TWALL3",
              #"SFX.TWALL4",      "SFX.TWALL5",      "SFX.TI_BLD",       "SFX.T_WIN1",
              #"SFX.TI_ROAD",     "X001WSN_RF1",     "X001RSN_RF1",      "X001TSN_RF1",
              #"X001ASN_RF",      "X001WSN_RD1",     "X001RSN_RD1",      "X001TSN_RD1",
              #"X001ASN_RD",      "SFX.TCANYON",     "SFX.QCANYON"]


    for field in fields:
        f = r_out.readfield(field)
        f.data = r_can.readfield(field).data
        r_out.writefield(f)
```

Figure 6: Copy_to_fp.py script with reduced fields

3 Results

Firstly, we present the evolution of the field SURFTEMPERATURE from guess file (upper air file), which represents soil temperature, and X001TG1, the same variable when using SURFEX. These can be compared to operational values (SURFTEMPERATURE_OPER) across four different locations shown on Figure 7, from April 1st to April 8th 2024. It is observed that the X001TG1 temperatures are close to the operational values, while SURFTEMPERATURE (blue line) has higher peaks at the maximum temperature.

Figure 8 illustrates the evolution of CLSTEMPERATURE from guess file, which represents the two meter temperature. In this experiment, it is equivalent to SFX.T2M, although it begins with a different initial value.

A one week forecast was conducted and verification was done with HARP tool from April 1st to April 8th 2024 for 36 hour forecast. Experiment with inline SURFEX is sfx01 and si01 is operational ALARO without SURFEX. On Figure 9 is shown 2 m temperature which has more negative BIAS and higher RMSE for experiment sfx01. Figure 10 shows for mean sea level pressure BIAS is lower for first 24 hours of forecast and after that is close to operational. RMSE is higher than operational for all forecast hours. Also direciton of wind on 10 m has lower BIAS but higher RMSE than operational. Other variables like relative humiditiy and specific humidity has mixed BIAS and higher RMSE than operational. Experiment needs tuning to get better forecast results.

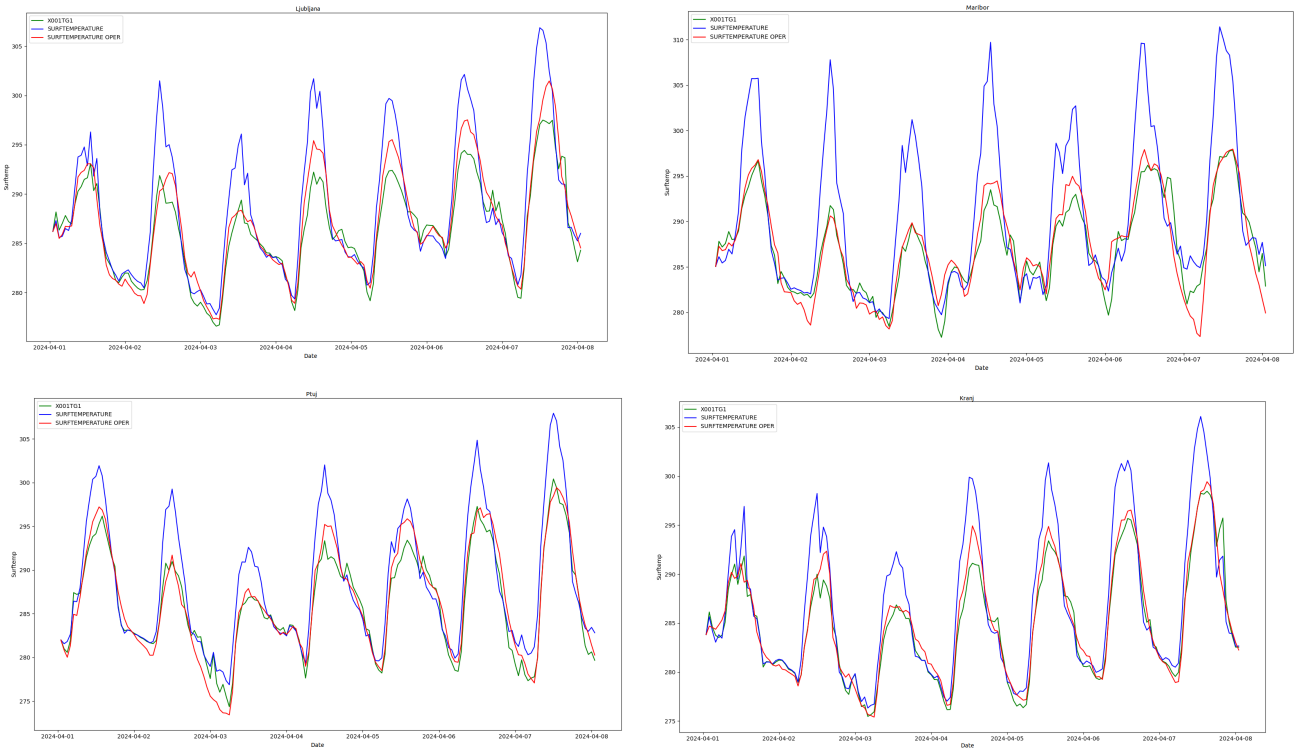

Figure 7: Evolution of fileds SURFTEMPERATURE and X001TG1 for different locations from April 1st to April 8th 2024

One case of rain was observed in that period. Figure 11 presents radar plots, the operational forecast of rain and forecast of rain with SURFEX for April 1st, 2024 at 17 UTC. Forecast with SURFEX predicts precipitation over a smaller area compared to the actual observed precipitation.

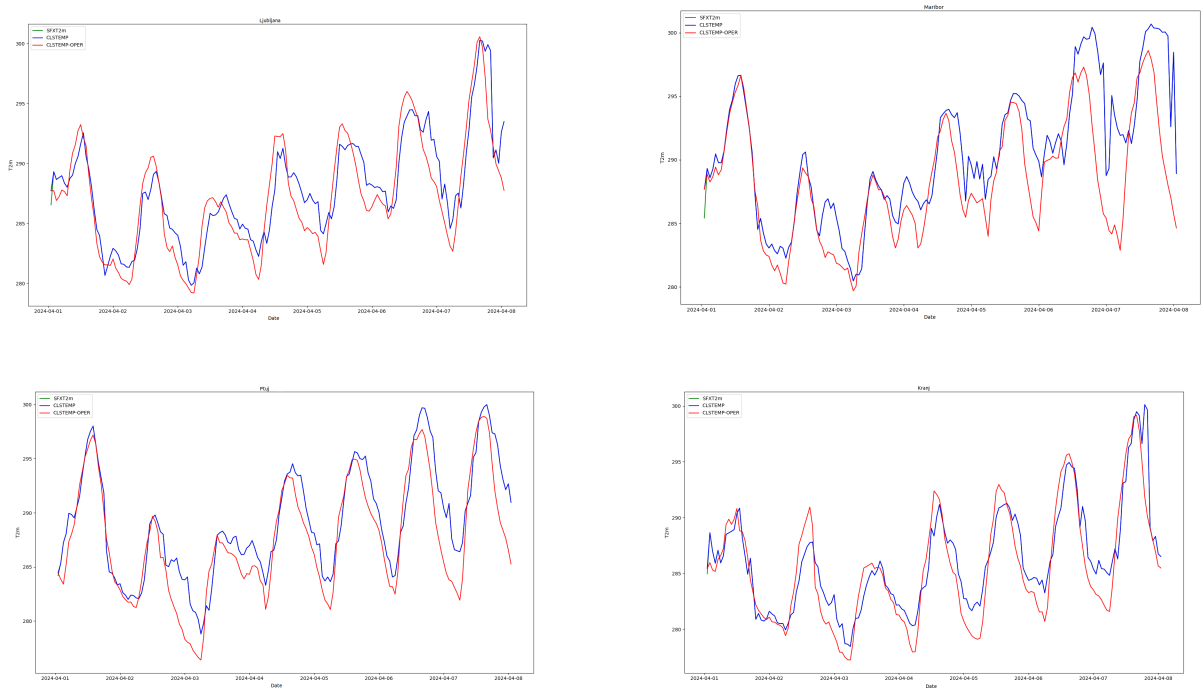

Figure 8: Evolution of fileds CLSTEMPERATURE and SFX.T2M for different locations from April 1st to April 8th 2024

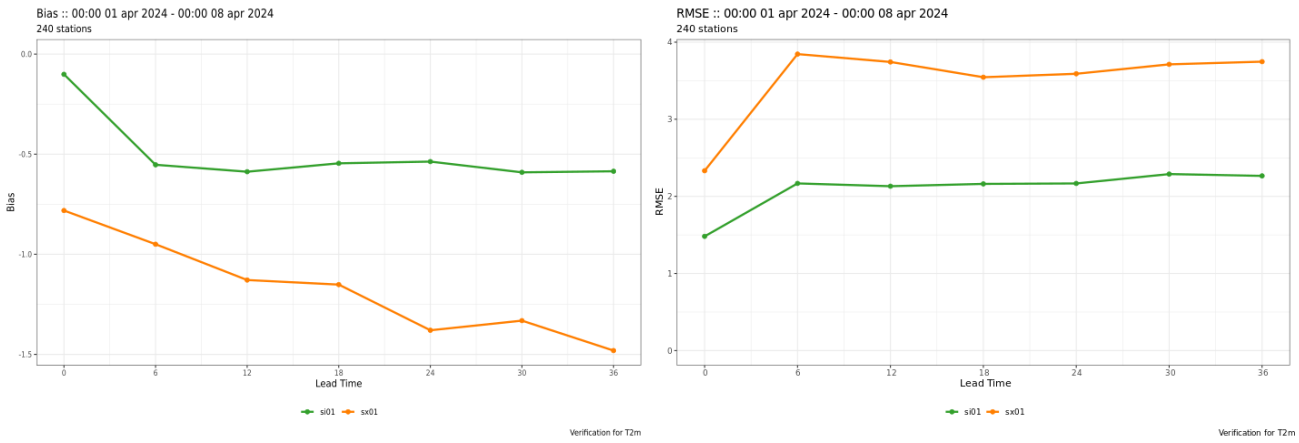

Figure 9: BIAS and RMSE for 2 meter temperature from April 1st to April 8th 2024

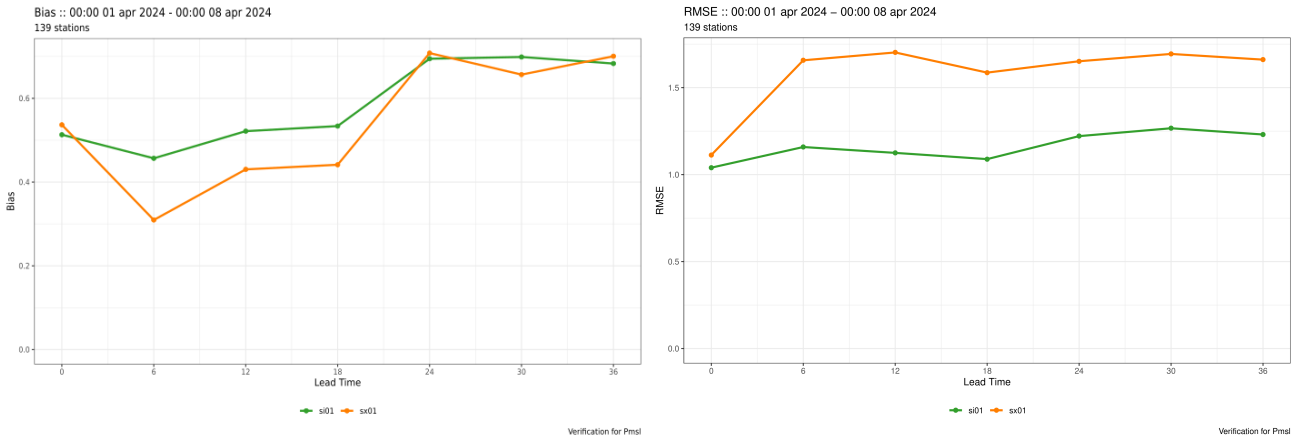

Figure 10: BIAS and RMSE for mean sea level pressure from April 1st to April 8th 2024

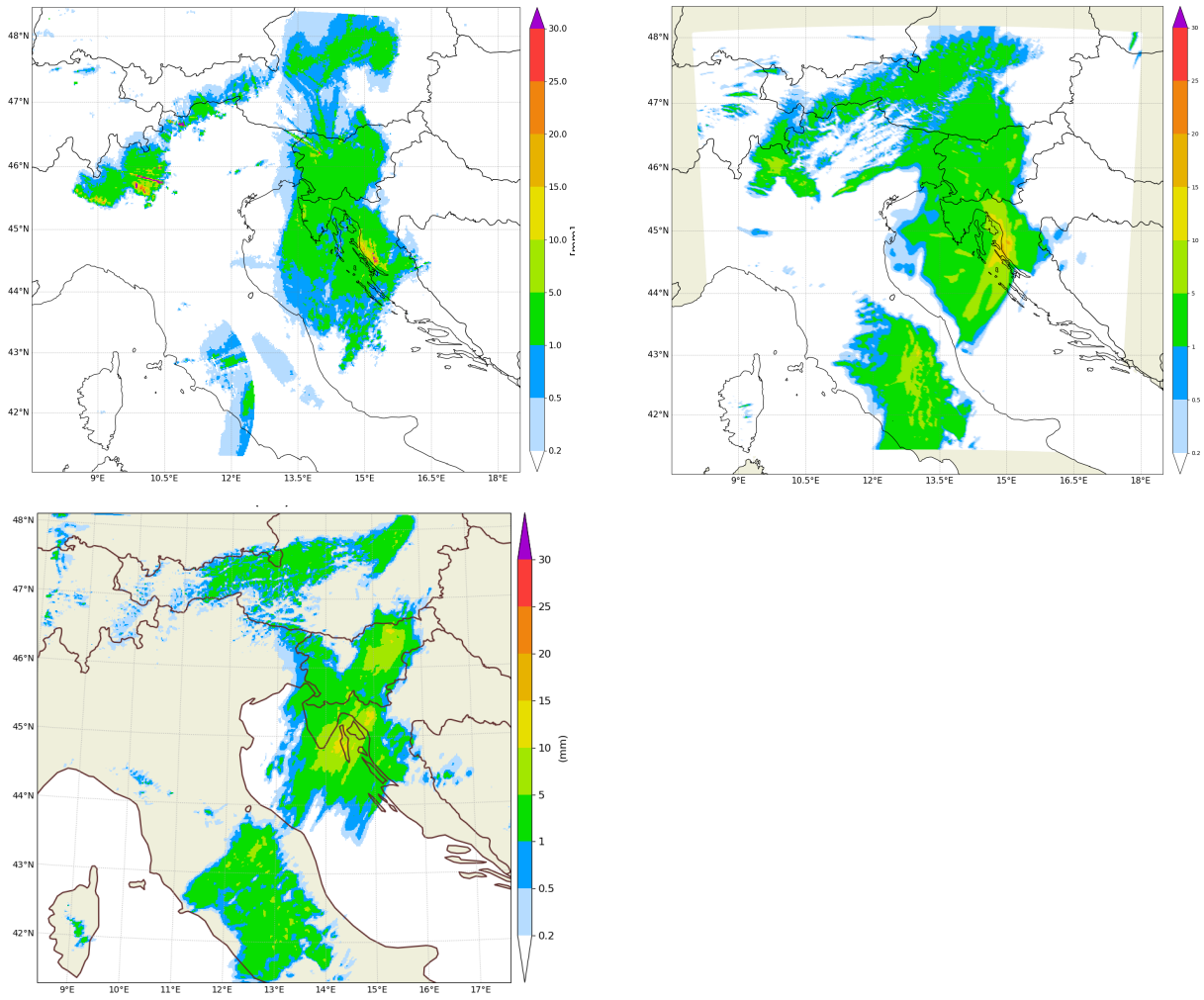

Figure 11: Radar plot (first row left), forecast of precipitation operational (first row right) and with surfex (second row) for 01.04.2024. 17 UTC

4 Conclusion

An assimilation cycle using ALARO coupled with SURFEX was conducted, and the evolution of surface fields was compared between SURFEX and ISBA. The fields SURFTEMPERATURE and X001TG1 were found to be close to each other, and CLSTEMPERATURE was the same as SFX.T2M. A one week run with ALARO/SURFEX was performed, and the results showed that the operational model performed better. We have demonstrated that an assimilation cycle ALARO coupled with SURFEX can be performed, but technical issues with CANARI (possibly related to input/output) need to be resolved before we can make a proper comparison.