Towards the 46T1-based common MUSC experiment

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- **Time:** 03/04/2023 - 07/04/2023
- **Location:** Finnish Meteorological Institute (FMI)
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- **Visitor:** Ana Šljivić (DHMZ, Croatia)

1 Introduction

Signle column model computations are very fast and useful for testing and developing a new code and parameterizations. Across the ACCORD community, there are different physical parameterizations and different separate developments. In the Cloud Aerosol Radiation Working group, different developments are going to be merged in the one common code (work ongoing by Piotr Sekula). The idea for this stay was to make the common MUSC experiment to be able to make experiments for all three CSCs (ALARO, AROME, HARMONIE-AROME) with the new code developments.

2 Procedure

The common code is currently based on the cy46t1.
Starting point was AROME 3D experiment. From 3D, following changes were made to make 1D experiment (Table 1). Switch LSFORC should be set to TRUE to read the main namelist for MUSC, NAMLSFORC. In that namelist, LMUSCLFA should be TRUE to get output written in LFA files. The rest of the namelist are mainly switches for setting different forcings (more in documentation from Sylvie Malardel).

Table 1: Differences between the reference 46T1 AROME 3D experiment namelist and the MUSC experiment

	3D	**MUSC**
NAMCT0		
LSFORC	F	T
NAMDYN		
NSITER	1	0
VMAX2	320	100
VMAX1	220	100
NAMDYNA		
LNESC	T	F
LPC_CHEAP	T	F
LPC_FULL	T	F
LSETTLS	F	T
NAMLSFORC		
LMUSCLFA	F	T
RELAX_TAUQ	0	3600
RELAX_TAUT	0	3600
RELAX_TAUU	0	3600
NAMPAR0		
NPROC	128	1
NPRINTLEV	1	0
NAMRIP		
TSTEP	60	15

Experiment was made for a case of a Saharan dust intrusion case from 20/02/2021 and location is Prague. Input files were made by Laura Rontu from the output of a 3D AROME experiment by using gl.
HARMONIE, AROME and ALARO experiments were run.
For AROME and ALARO, simulation was unstable until time step was decreased to 15 seconds (Table 1). Radiation scheme used was ACRANEB2, but experiments with IFS radiation were also performed.
For ALARO, a few additional modifications have to be added to be able to run it without SURFEX:

- LMSE=FALSE
- LSFORCS=TRUE
- 25 surface fields have to be in the initial file.

2.1 NCOUPLING

In single column model, there are no lateral boundary conditions. From the module yom_ygfl.F90, there is switch for coupling the GFL fields, NCOUPLING:

- 1 if field is coupled by Davies relaxation,
- 0 if not,
- -1 if coupled with reference value for coupling REFVALC.

Since there are no lateral boundary conditions, value for NCOUPLING should be set to 0.

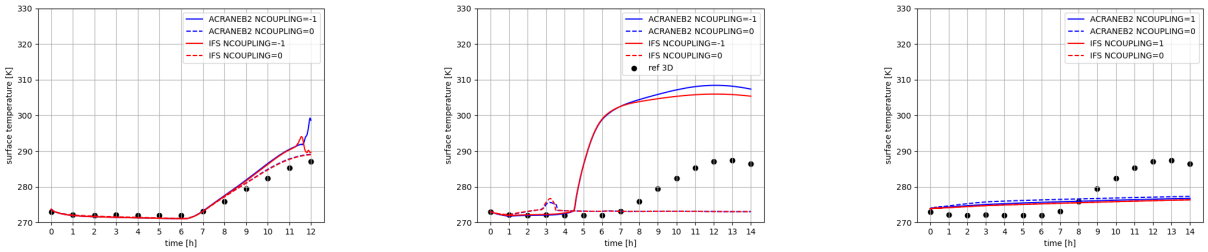
Results of all the above mentioned changes will be shown in the next section.

3 Results

Surface and vertical profile time series of temperature, shortwave and longwave radiation will be shown in Figures 1 - 6. As a reference, 3D AROME experiment for that location is taken (black dots).

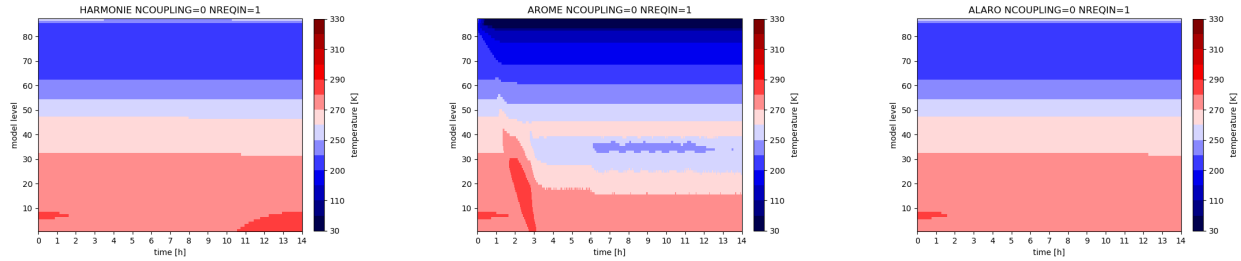
3.1 Temperature

Surface temperature of HARMONIE MUSC experiment is following well the 3D AROME reference with NCOUPLING set to 0 for both radiation schemes. When NCOUPLING switched to -1, strange results occur after 11^{th} forecast hour. For AROME MUSC, strange peak in surface temperature is present at 3^{rd} forecast hour, while after that, temperature returns to original state and no reaction to sunrise is visible. With NCOUPLING switched on, temperature starts to rise 2 hours before sunrise, and that rise is non physical. Experiments with ALARO did not show big differences among each other, with or without NCOUPLING and for both radiation schemes. There was also almost no reaction to the sunrise.
Vertical profiles are shown only for NCOUPLING=0, as it should be in 1D experiment. HARMONIE results look reasonable, AROME has strange wave coming from the top of the atmosphere (where too low temperatures are present). ALARO temperature profile seems reasonable for higher levels, while at surface there is no increase of temperature due to sunrise.



(a) HARMONIE (b) AROME (c) ALARO

Figure 1: Surface temperature for HARMONIE, AROME and ALARO MUSC experiments and 3D reference (black dots). Blue line is experiment with ACRANEB2 radiation, while red line is IFS radiation.

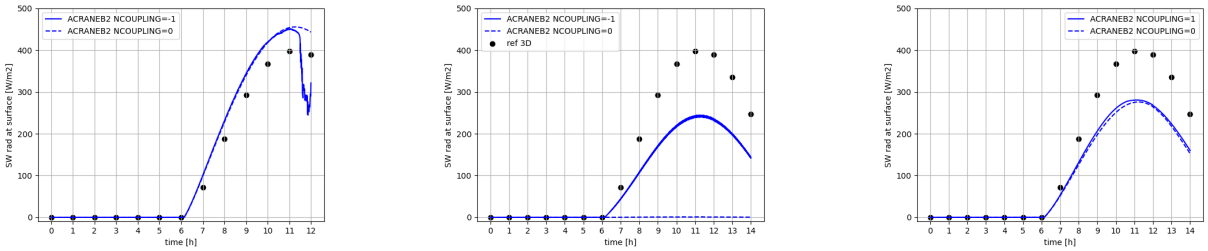


(a) HARMONIE (b) AROME (c) ALARO

Figure 2: Vertical profiles of temperature for HARMONIE, AROME and ALARO MUSC experiments

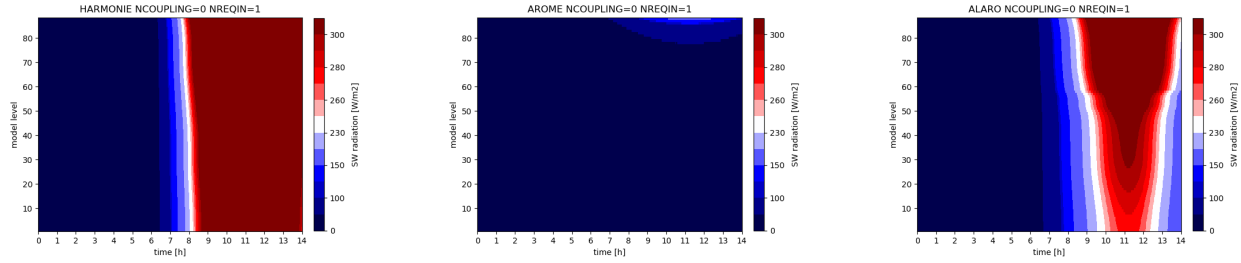
3.2 Shortwave and longwave radiation

For shortwave and longwave radiation, only experiments with ACRANEB2 will be shown.
As for surface temperature, shortwave and longwave radiation for HARMONIE follow well the 3D reference. Experiment with NCOUPLING=1 shows too little shortwave and too much longwave radiation after the 11^{th} forecast hour.
AROME experiment without coupling has no change in shortwave nor longwave radiation, even after sunrise. That behaviour is visible also through the whole vertical profile.
ALARO experiment, as for the temperature, shows reasonable behaviour at higher levels, while at surface there is too little changes in both shortwave and longwave radiation.



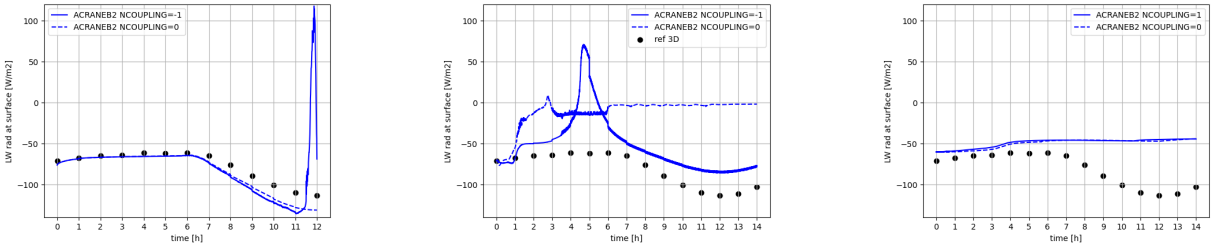
(a) HARMONIE (b) AROME (c) ALARO

Figure 3: Shortwave radiation at the surface for HARMONIE, AROME and ALARO MUSC experiments and 3D reference (black dots).



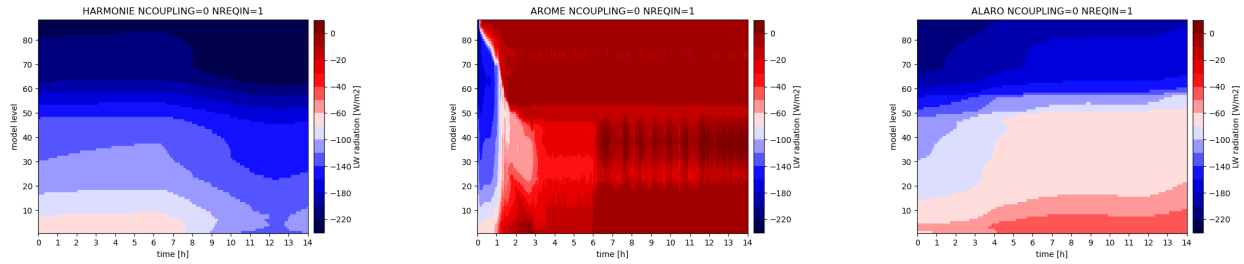
(a) HARMONIE (b) AROME (c) ALARO

Figure 4: Vertical profiles of shortwave radiation for HARMONIE, AROME and ALARO MUSC experiments



(a) HARMONIE (b) AROME (c) ALARO

Figure 5: Longwave radiation at the surface for HARMONIE, AROME and ALARO MUSC experiments and 3D reference (black dots).



(a) HARMONIE (b) AROME (c) ALARO

Figure 6: Vertical profiles of longwave radiation for HARMONIE, AROME and ALARO MUSC experiments

4 Conclusion

During this stay, I tried to make a MUSC experiment from 3D AROME experiment which would work for all three CSCs. Input files were made by Laura by using gl on the 3D experiment output files.
A few changes were made in the runtime namelist, most important is to switch LSFORC and LMUSCLFA to TRUE. Additionaly, some changes in dynamics were necessary to have stable runs for AROME and ALARO. Results show that HARMONIE is following 3D reference well. AROME has strange "wave" propagating from the top of the atmosphere to the surface. ALARO has no changes at the surface, while higher levels seem to be reasonable. All three configurations show different behavior depending on the switch NCOUPLING. Next step will be to check if input files may caused the problem.