Regional Cooperation for
Limited Area Modeling in Central Europe

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ALARO CSC, Code Refactoring and Testing

Martina Tudor (and many many others)

GeoSphere Austria · DHMZ · Czech Hydrometeorological Institute · OMSZ · IMGW · METEO ROMANIA · SHMU · ARSO METEO Slovenia

Overview

ALARO code is regularly phased with ARPEGE and is included in the ‘T’ cycles and written using the same rules

New data structures are being introduced

Split of aplpar - the main physics calling routine for both ALARO and ARPEGE -> apl_alaro.F90

Code cleaning

Removal of computations from upper level routines: mf_phys and apl_alaro into specific subroutines

Organizing the calling of different parametrisations into separate blocks

Initial Conditions

very long subroutines and big computational blocks are not suitable for automatic translation to GPUs

ALARO physics called from the same aplpar as ARPEGE

Code and structures used in ARPEGE and ALARO are similar

Computations done at all levels in the code

Many items shared with ARPEGE:

- Data flow
- Allocations of local variables
- Initialization …

New Structures

Starting point was cy48t3

New data structures already included into aplpar

apl_arpege already set up

There are rules, but rules are meant to be broken …

- introduction of smart structures (FIELD_API)
- introduction of directives !=PARALLEL
- removal of GFL loops

Many thanks to Pillippe Marginaud

Working week, CHMI 7-11 Nov 2022

apl_alaro

The needed options are defined and aplpar filtered through automatic tool removal of obsolete and ARPEGE-only switches and arrays: LTRAJPS, LINTFLEX, LAJUCV, LGPCMT, CGMIXLEN in { 'TM','TMC','Z','AYC' }, LECT, LNORGWD, LRAYFM, RAYSP, LRCOEF, LNEBECT, LRKCDEV, LCVRAV3, LCVTDK, LEDMFI, LMCC03, LPROCLD, LACDIFUS, LEDKF, LCVPPKF, LNEBCO, LGWDC, LADJCLD, BAYRAD, LCORWAT, CPCHET, PROFILECHET, LAROME, LMPHYS, LCHEM_ARPCLIM, LCVPGY, LNEBR, LSTRA, LSTRAS, LCVRA

apl_alaro set up, Identified blocks with clear input and output

Initialization block (including correction of negative values)

- Turbulence
- Mixing length
- Microphysics and convection
- Radiation
- Diagnostics and postprocessing (will have to be distributed)
- Surface (turbulence)
- Dust

apl_alaro

Initialization init, qneg, precip, init_surf blocks +/- finished, with bitwise reproducibility

Diagnostics and output
- precipitation types coded in apl_alaro_prectype, tests show no impact on prognostic fields
- clouds (low/medium/high) have their own subroutine and are to remain where they are since needed there
- precipitation fluxes - strong dependency on deep convection and microphysics, documenting and checking dataflow
- 2m and 10m stuff - strong dependency on turbulence (Mario) and surface (Bogdan) blocks
- lightning, visibility, etc - moved to the end and interfaced

Testing apl_alaro on belenos

Three tests set up on belenos for various physics set ups of ALARO:

- Alaro 0
- Alaro 1
- Alaro 1 with graupel

Also a small test on ECMWF machine

- To be complemented with the tests from belenos (SBU accounting)

What is considered done gives bit-reproducible results

Outcome of the working week

- exercise seems useful even without GPU adaptation in mind:
  - clearer code structure and dataflow between blocks
  - identification of bugs or inconsistencies
  - reduced memory footprint because of removal of unused arrays
  - improved efficiency thanks to removal of unnecessary initializations

After the working week

- created 48t3 rootpack and test cases on ECMWF ATOS
- finish extraction of blocks
  a. Done for radiation
  b. Postprocessing either done or part of other blocks
  c. Turbulence and microphysics making good progress
  d. Initialization and surface
- apply fxtran-based scripts on refactored APL_ALARO
- find solution for array GFL fields EXT and EZDIAG
- remove references to PGFL, ZTENDGFL, PGFLT1 and PGMVT1
- minor changes to be carried out

Tests using ALARO (VHR example)

Test prepared for AROME using CY43T1 on Belgian domain in 700m

- https://opensource.umr-cnrm.fr/projects/accord/wiki/Belgium_Arome_700m (Thomas Vergauwen)

Has been adapted to run ALARO with or without SURFEX

Details here

https://opensource.umr-cnrm.fr/projects/accord/wiki/Belgium_ALARO_700m

ALARO modifications for e927 namelist

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- ALARO requires to create new input files for e927
  - **Spectral specific humidity (gridpoint in AROME)**
  - **Additional surface fields for old ISBA (the fields are required for runs without SURFEX!)**
- **Namelist changes:**
  - **LAROME=.F.,**
  - **'SURFZ0.FOIS.G','SURFALBEDO','SURFEMISSIVITE','SURFET.GEOPOTENT',**
  - **'SURFIND.TERREMER','SURFPROP.VEGETAT','SURFVAR.GEOP.ANI','SURFVAR.GEOP.DIR',**
  - **'SURFIND.VEG.DOMI','SURFRESI.STO.MIN','SURFPROP.ARGILE','SURFPROP.SABLE',**
  - **'SURFEPAIS.SOL','SURFIND.FOLIAIRE','SURFRES.EVAPOTRA','SURFGZ0.THERM',**
  - **'SURFRESERV.INTER','PROFRESERV.GLACE','SURFRESERV.GLACE','SURFDENSIT.NEIGE',**
  - **'SURFALBEDO NEIGE','SURFALBEDO.SOLNU','SURFALBEDO.VEG',**
  - **NFPCLI=3, LFPQ=.F., RFPCORR=35000., RFPCSAB=130.,**
  -
  - **/perm/hr4/belgium_setup/name/name.e927.alaro07**

ALARO namelist modifications for e001

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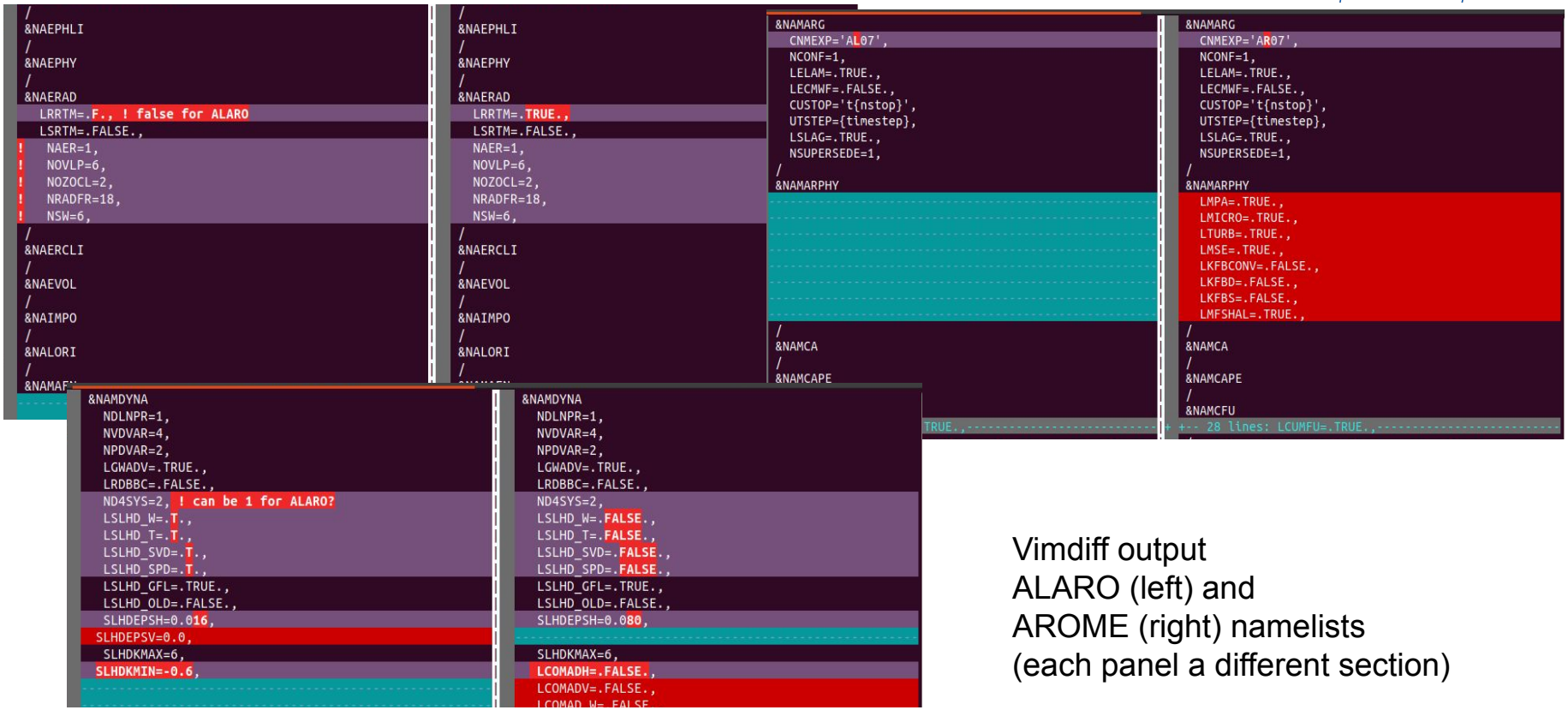

Vimdiff output
ALARO (left) and
AROME (right) namelists
(each panel a different section)

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ALARO namelist modifications for e001

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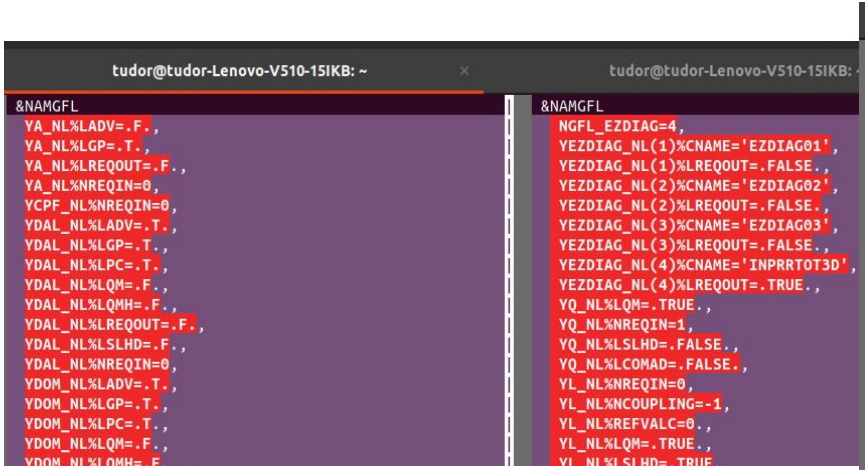

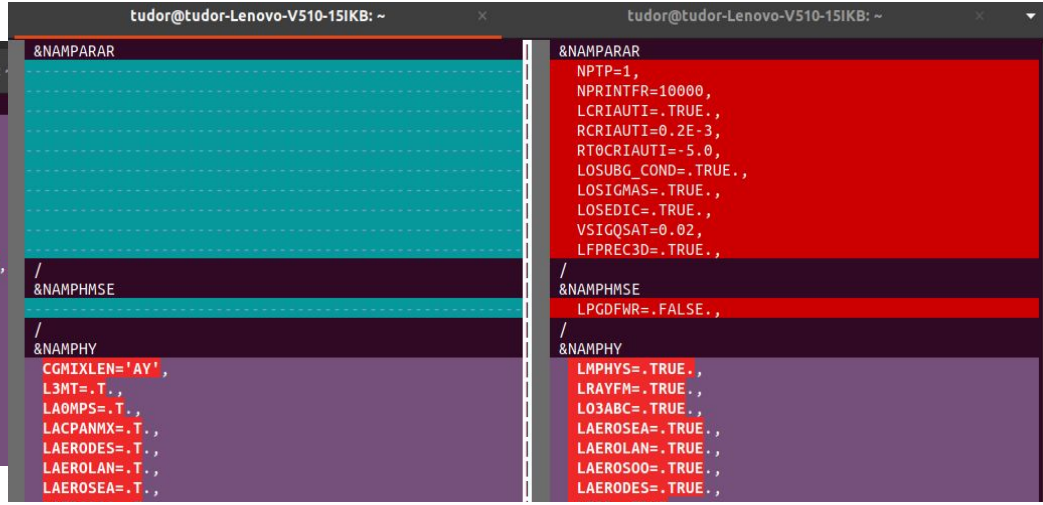

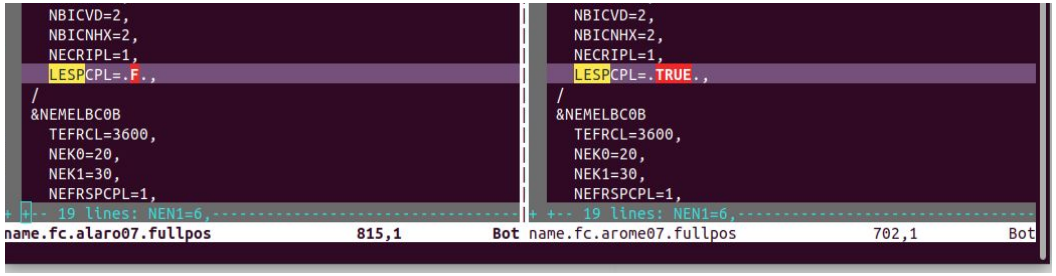

Vimdiff output
ALARO (left) and
AROME (right) namelists
(each panel a different section)

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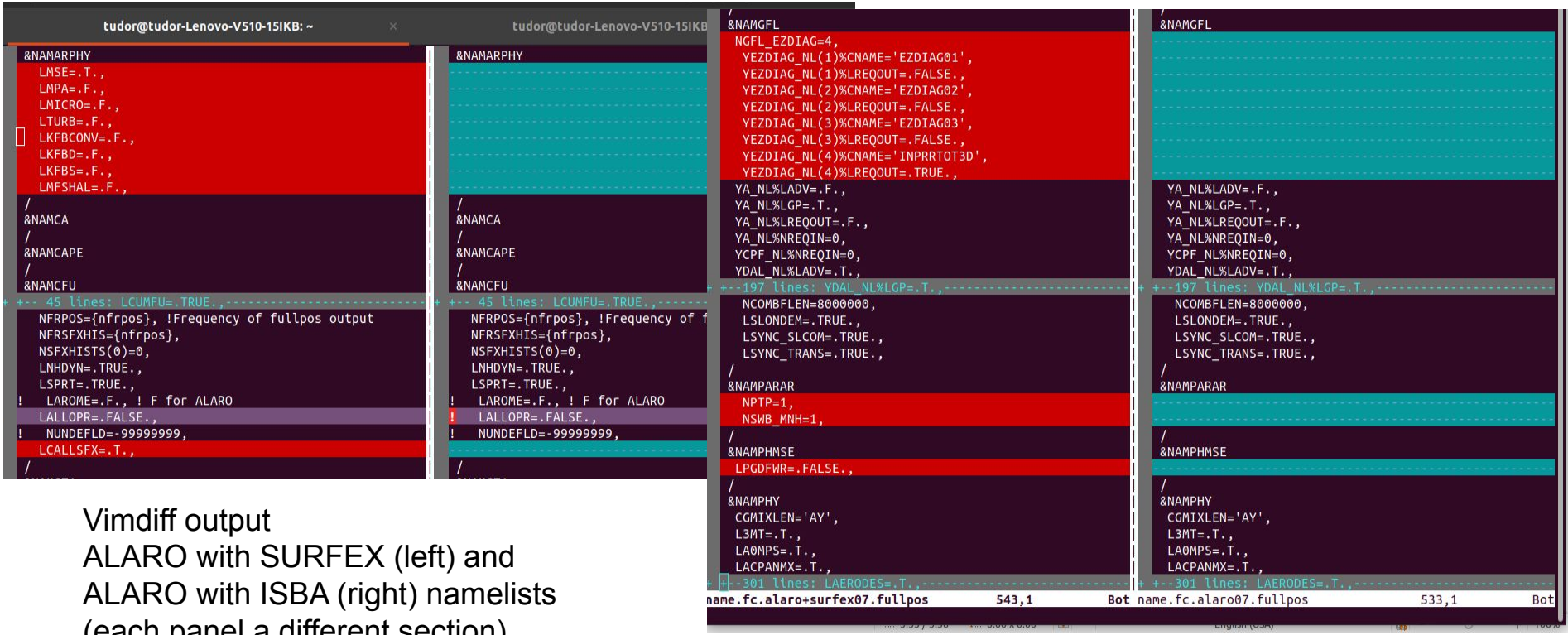
ALARO0 with surfex

- Same input as for ALARO without SURFEX
- EXSEG1.nam:
  - &NAM_DIAG_SURFn
  - LSURF_BUDGET=.TRUE.,
  - N2M=2, ! scheme for interpol to 2m (2=Geleyn)
  - **LCOEF=.T.,**
  - /
  - &NAM_SURF_ATM
  - XRIMAX=0.0,
  - **LDRAG_COEF_ARP=.T.,**
  - /

ALARO0 with surfex



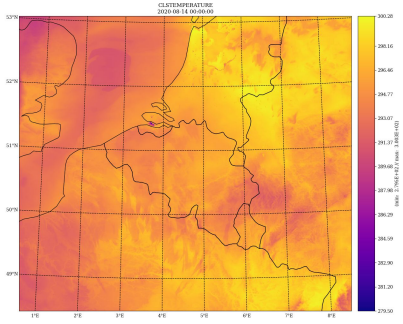
Vimdiff output
ALARO with SURFEX (left) and
ALARO with ISBA (right) namelists
(each panel a different section)

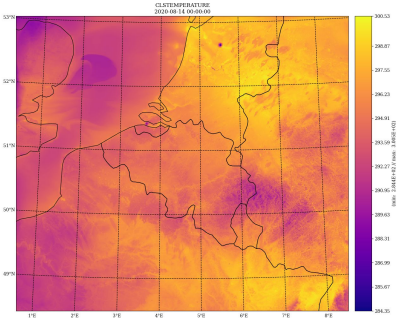
ALARO tests summary

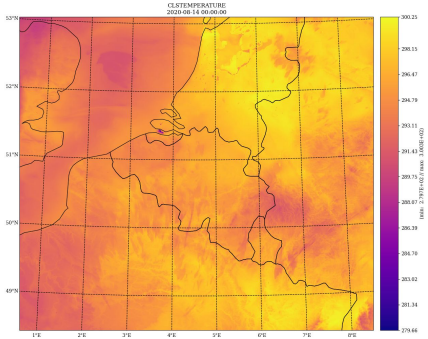
namelist	version	SURFEX	deep convection
name.fc.alaro07.fullpos	ALARO0	OFF	ON
name.fc.alaro107.fullpos	ALARO1	OFF	ON
name.fc.alaro+surfex07.fullpos	ALARO0	ON	ON
name.fc.alaro1+surfex07.fullpos	ALARO1	ON	ON
name.fc.alncv07.fullpos	ALARO0	OFF	OFF
name.fc.al1ncv07.fullpos	ALARO1	OFF	OFF
name.fc.alncv+surfex07.fullpos	ALARO0	ON	OFF
name.fc.al1ncv+surfex07.fullpos	ALARO1	ON	OFF

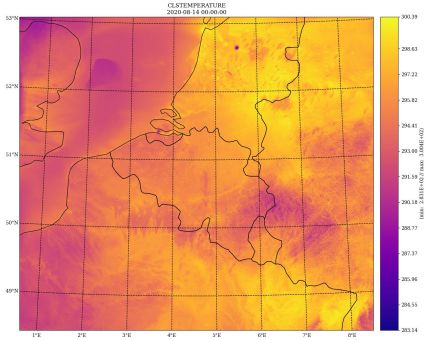
Disclaimer: these namelists work and do not produce complete rubbish of the forecast fields, stuff in both dynamics and physics could be retuned for 700m and 20 second timestep. Also, they do work with SURFEX (see figures below), but this is an example with short time step, summer (no snow) and (ahem) no mountains. Also, the colour scale varies from one experiment to another (it gets automatically adjusted).

ALARO0 tests summary



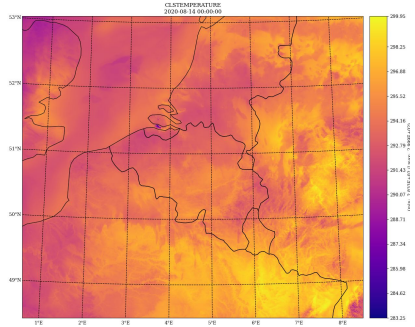


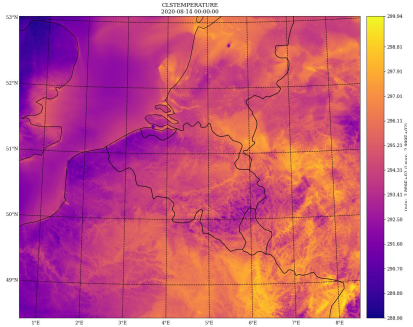


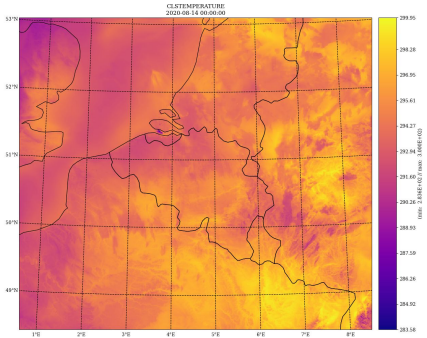


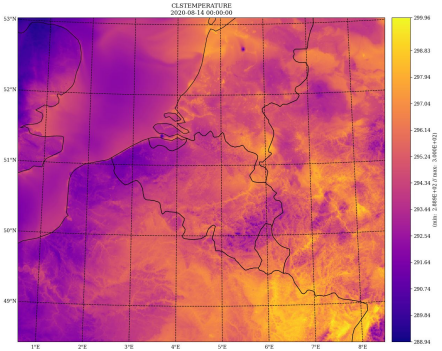
Examples of 24 hour forecasts of 2m temperature for ALARO0 run in 700m over Belgium using ALARO0 set ups with old ISBA (1&3) with SURFEX (2&4), with deep convection parametrisation on (1&2) and off (using only resolved precipitation, 3&4). Warning: the coulour range is different!

ALARO1 tests summary









Examples of 24 hour forecasts of 2m temperature for ALARO1 run in 700m over Belgium using ALARO0 set ups with old ISBA (1&3) and with SURFEX (2&4), with deep convection parametrisation on (1&2) and off (using only resolved precipitation, 3&4). Warning: the coulour range is different!

ALARO stuff (but not really)

In ALARO we also use some options that are not tied to the physics package and could be used with any other physics

- SLHD (in 001, use LSLHD=.T. in dynamics and for GFLs too)
- Blending (as part of DA)

Issues

MUSC
- Meant to be run on a laptop but
  - Difficult to port (Works in a container)
  - Tools to be used from MF

“Reference” libraries, executables
- On belenos
- On Atos (REK)

Scripts and namelists (and input files) for tests
- (no vortex)

ALARO+SURFEX
- Input files for different SURFEX versions
- Debugging SURFEX

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Thank you for your attention.

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ARSO METEO Slovenia