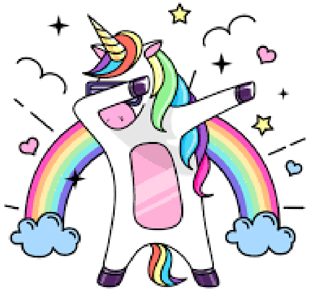
***R**egional **C**ooperation for*
***L**imited **A**rea Modeling in **C**entral **E**urope*

LACE Physics report

Martina Tudor

Summary of activities

- code contribution for phasing CY47T1
- Code Training, MF, Toulouse, 9-13 September 2019
- new post processing output fields
- TOUCANS turbulence scheme
    - shallow convection
    - mixing length computation (cont.)
    - code check of TOUCANS
    - DDH
- Cloud scheme
- AROME microphysics: ICE3/4 and LIMA schemes
- prognostic graupel for ALARO
- operational applications: ALARO0 to ALARO1 +/- SURFEX
- computation of topographis characteristics from GMTED2010



Code contribution for phasing CY47T1

The first modset prepared by Bogdan Bochenek, containing **prognostic graupel code**.

The second modset prepared by Jan Mašek, containing several contributions:

1) **DDH budgets** for prognostic TKE and TTE (in TOUCANS) added by Mario Hrastinski.

2) **New cloudiness treatment in vertical diffusion** by Radmila (introducing new options NDIFFNEB=4 and 5).

3) **Fixes in adjustment and microphysics** by Luc Gerard. These will be deactivated by local key, since they require more extensive validation.

4) **TOMs** (3rd order moments in TOUCANS) fixes by Peter Smerkol. These will be deactivated by local key as well.

5) Further **modularization and optimization of ACRANEB2**.

6) **Fixes of blend utility** (new FA date structure, split of ECHIEN to ERIEN, reintroduction of Z_NSIGN, making official version working). Recently, Jan Masek found that blend utility in cy47t0 is crashing, the problem might be related to xrd adaptation for single/double precision.

Turbulence scheme - TOUCANS

TOUCANS – Third Order moments (TOMs) Unified Condensation Accounting and N-dependent Solver (for turbulence and diffusion)

The basic data flow from TKE/TTE solver to DDH input structure is completed and successfully tested with uniform input fields.

ddhb Postprocessing of TKE/TTE budget fields is completed

phasing this development within the next common cycle

TOUCANS – mixing length computation

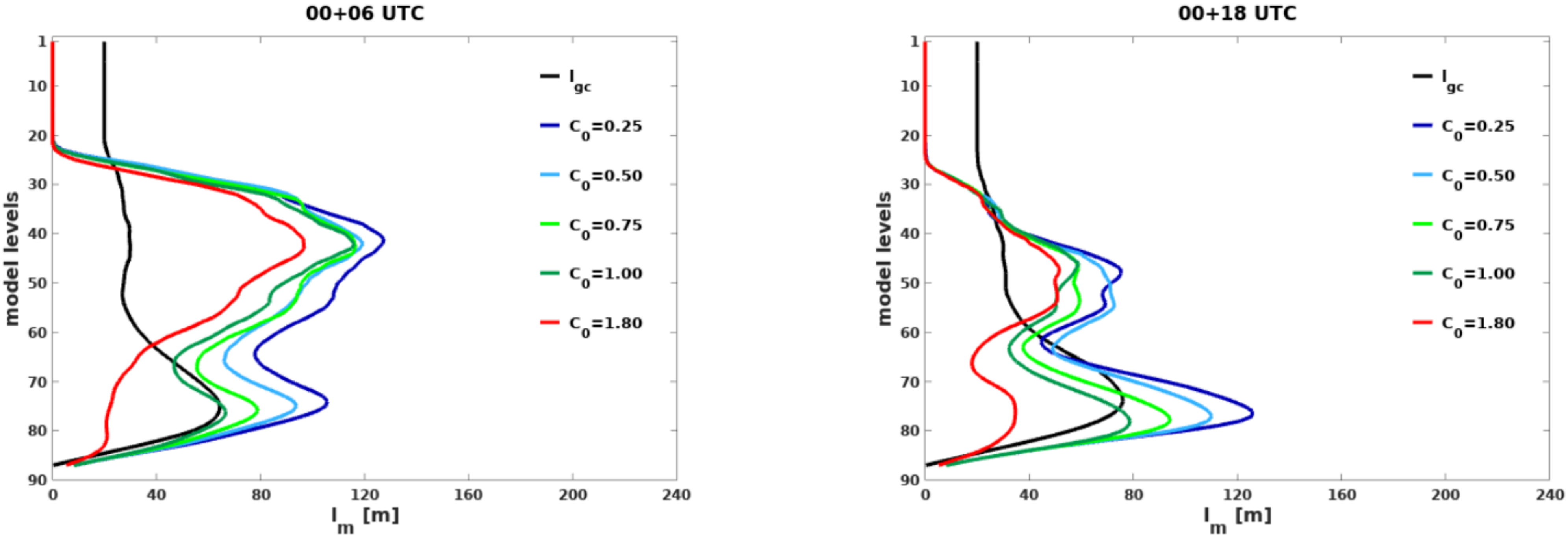


Figure 1: *Comparison of averaged vertical profiles of the reference l_m (Geleyn-Cedilnik formulation) and generalized BL89 options which differ in the magnitude of the shear term (C_0 constant).*

TOUCANS – mixing length computation

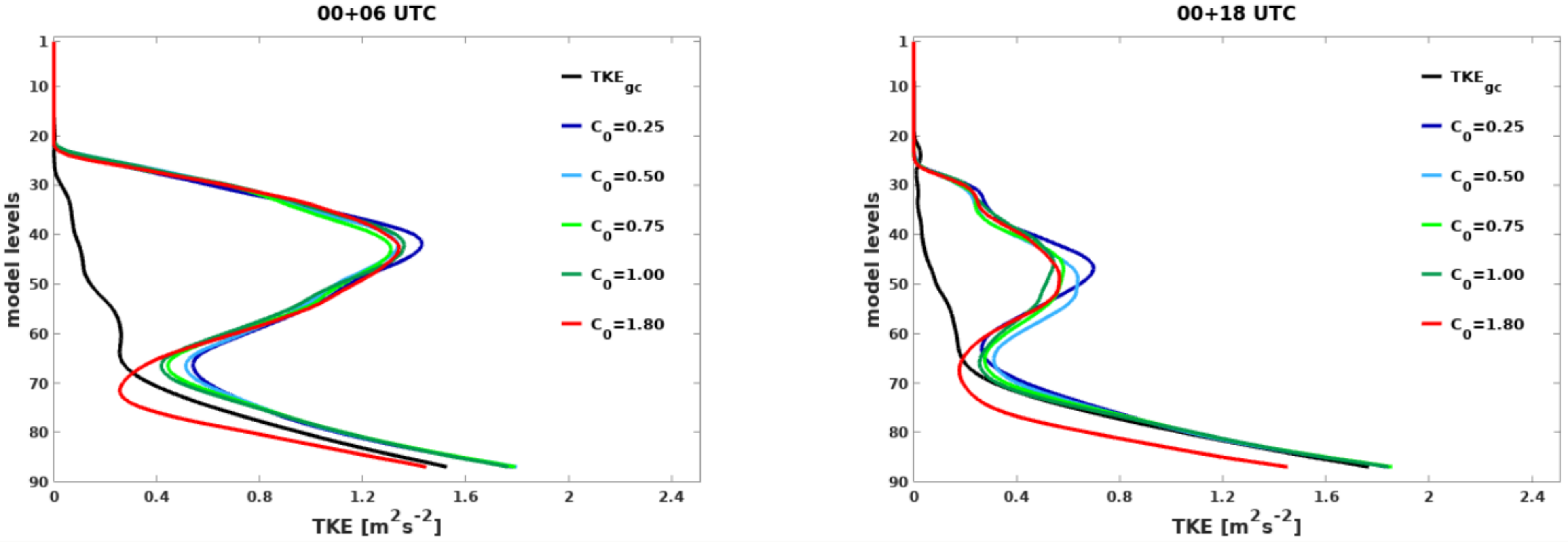


Figure 2: *Comparison of averaged vertical profiles of the reference TKE (uses Geleyn-Cedilnik formulation) and those obtained by using generalized BL89 options which differ in the magnitude of the shear term (C_0 constant).*

TOUCANS – mixing length computation

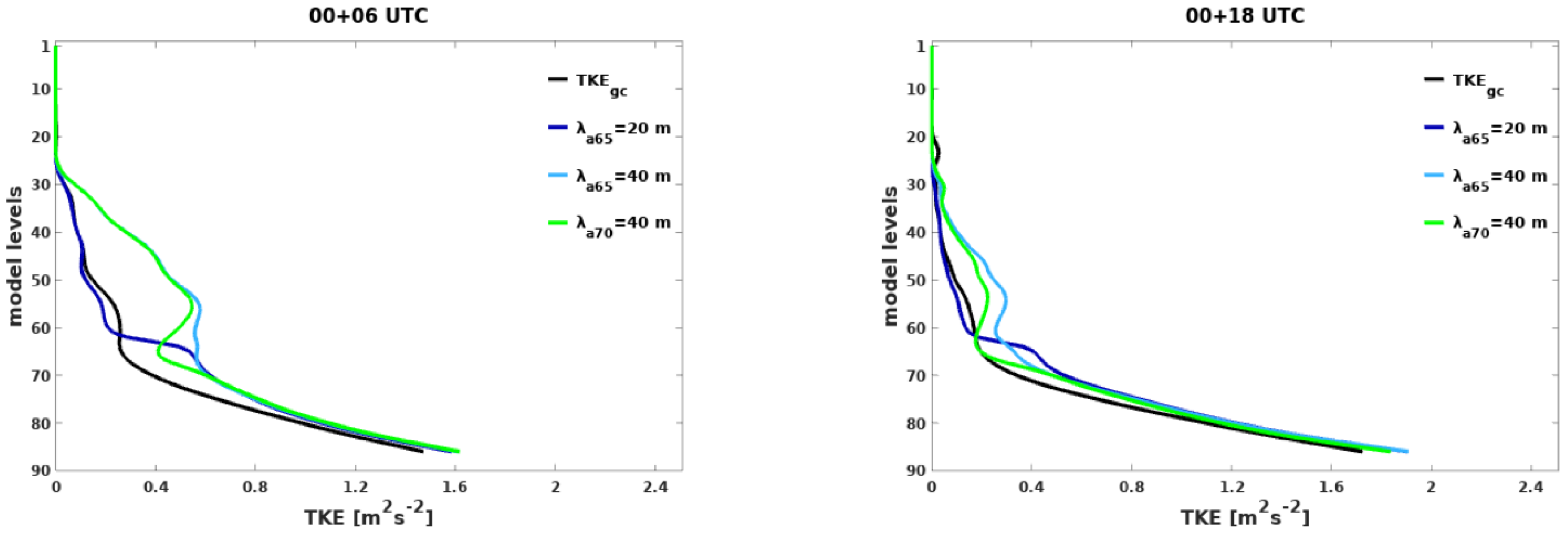


Figure 3: *Comparison of averaged vertical profiles of the reference TKE (uses Geleyn-Cedilnik formulation) and those obtained by using generalized BL89 options which differ in the magnitude of the shear term*

TOUCANS – mixing length computation

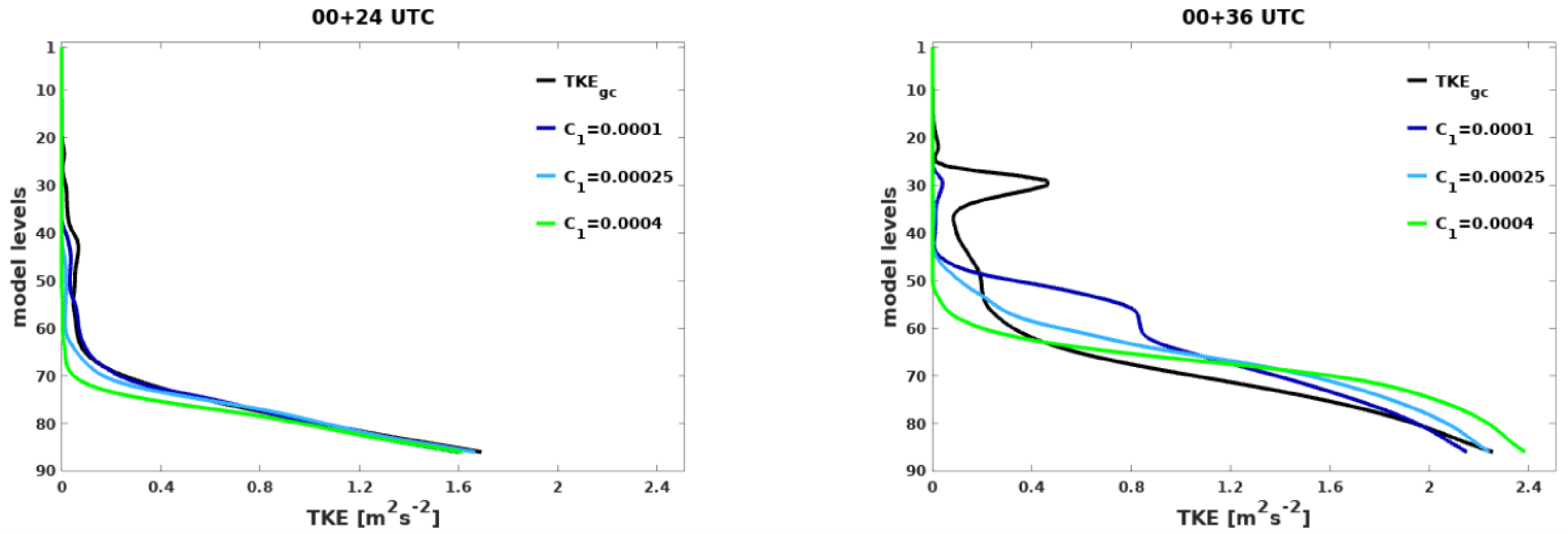


Figure 4: *Comparison of averaged vertical profiles of the reference TKE (uses Geleyn-Cedilnik formulation) and those obtained by using generalized BL89 options which differ in the magnitude of added third term*

ALARO + SURFEX

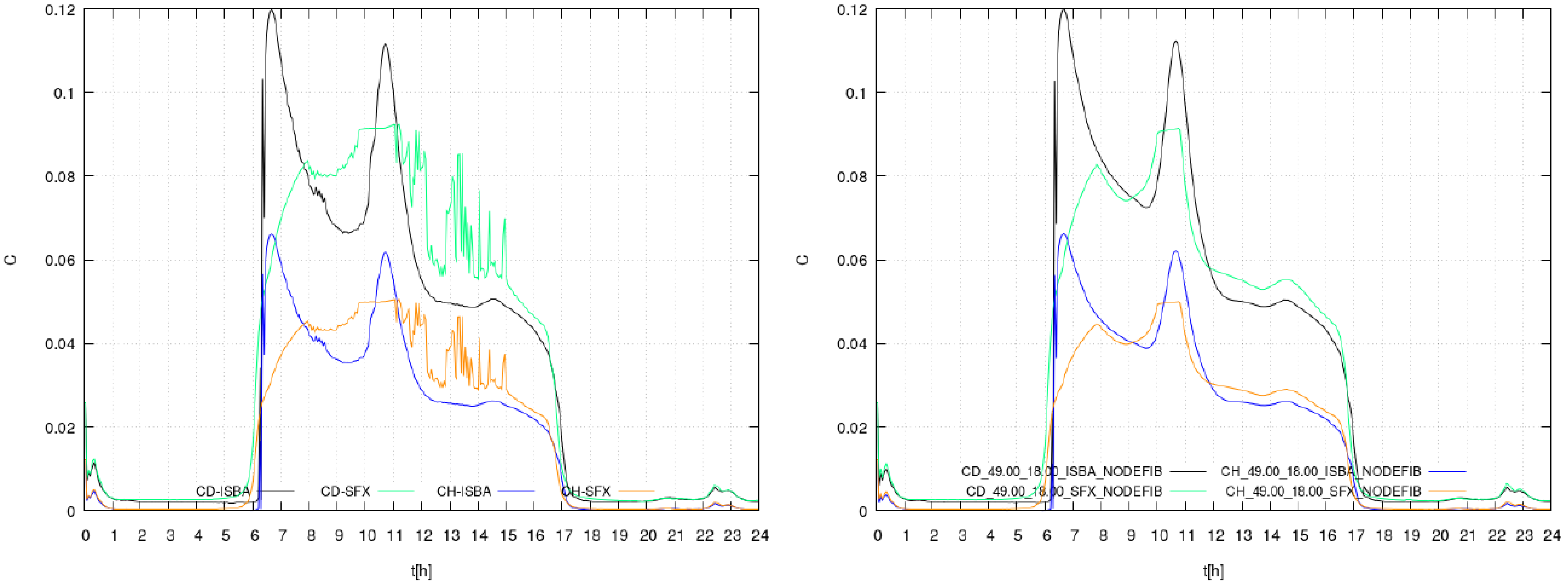


Figure 3.5: Evolution of the surface drag and heat coefficients for point 18°E, 49°N. **Left:** Antifibrillation treatment on. **Right:** Antifibrillation treatment off. **Black/green:** Surface drag coefficient for ISBA/SURFEX run. **Blue/orange:** Surface heat coefficient for ISBA/SURFEX run. Forecast base time 10-Sep-2018 at 00 UTC. ISBA run used surface roughness from SURFEX.

ALARO + SURFEX

Note:
use antifibrillation scheme for ALARO0
ALARO1 does not need antifibrillation

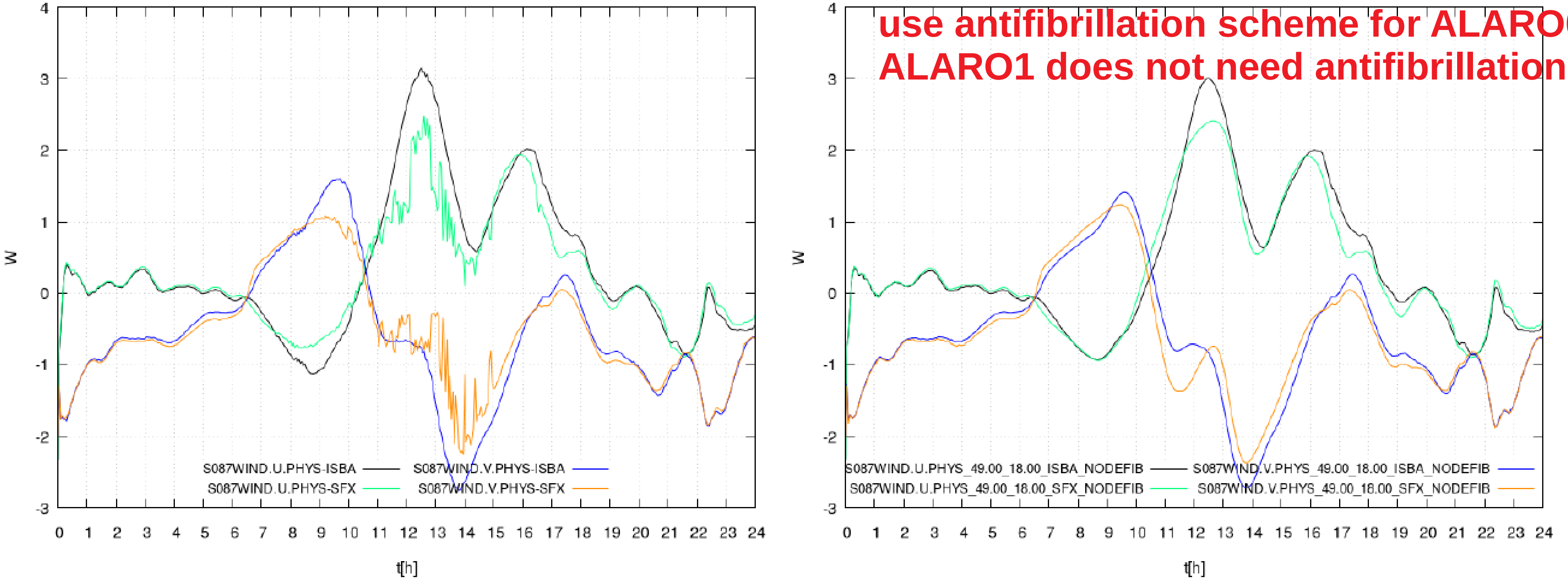
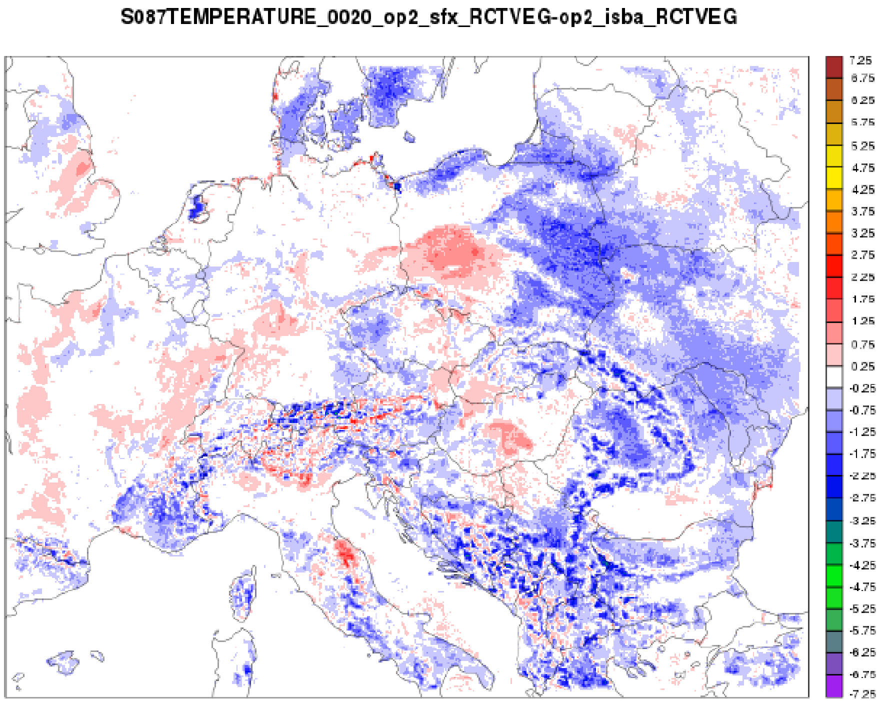
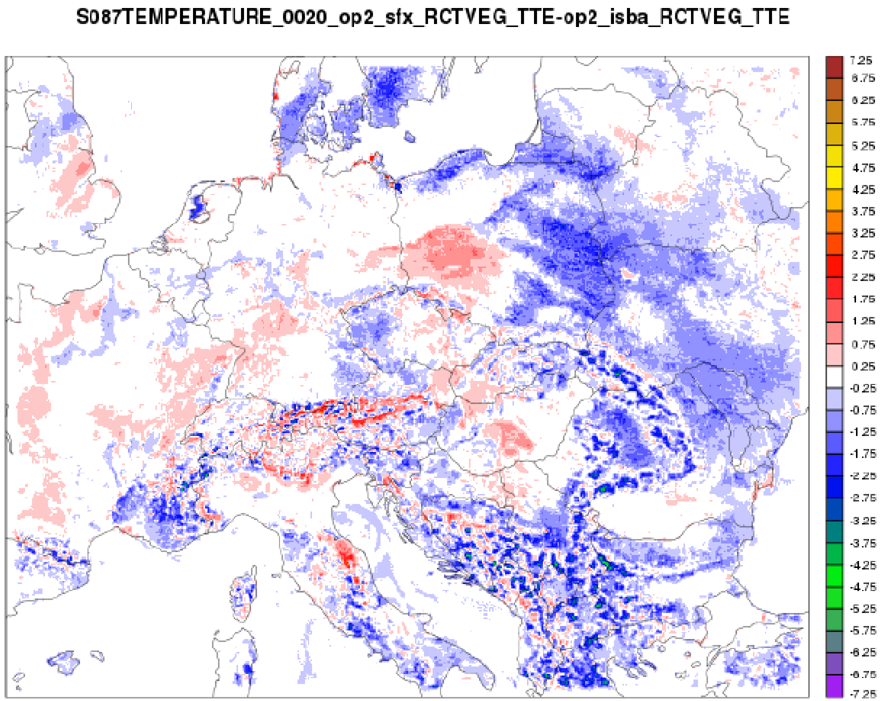


Figure 3.6: Evolution of the wind components at the lowest model level for point 18°E, 49°N. **Left:** Antifibrillation treatment on. **Right:** Antifibrillation treatment off. **Black/green:** U-wind component for ISBA/SURFEX run. **Blue/orange:** V-wind component for ISBA/SURFEX run. Forecast base time 10-Sep-2018 at 00 UTC. ISBA run used surface roughness from SURFEX.

ZAMG DHMZ Czech Hydrometeorological Institute OMSZ IMGW METEO ROMANIA SHMU ARSO METEO Slovenia

ALARO + SURFEX





SURFEX minus ISBA dierence it the lowest model level temperature. Run with (left) and without (right) prognostic TTE. 1h Forecast, base time 10-Jul-2017

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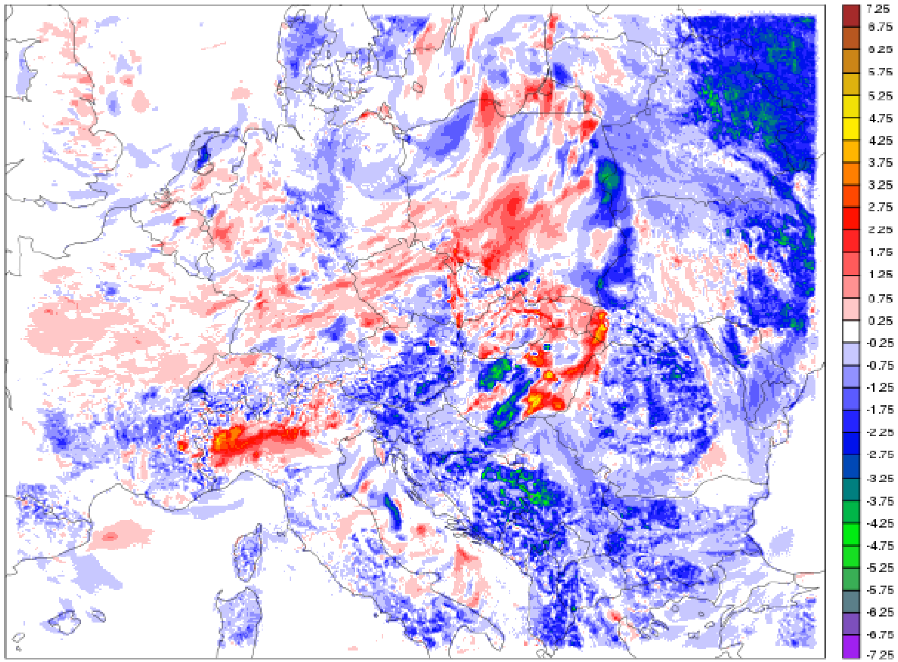
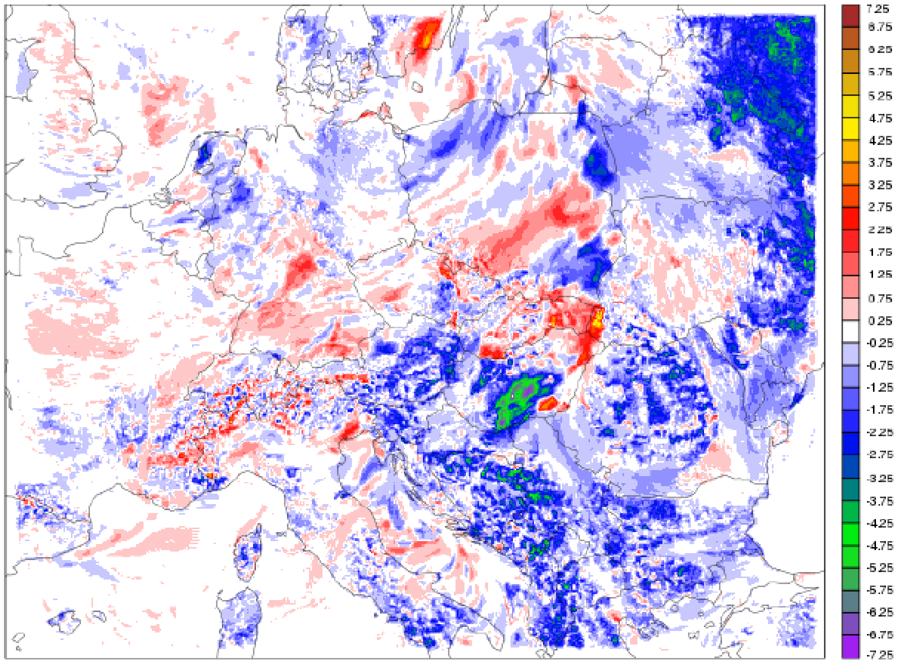
ALARO + SURFEX

S087TEMPERATURE_0480_op2_sfx_RCTVEG-op2_isba_RCTVEG



S087TEMPERATURE_0480_op2_sfx_RCTVEG_TTE-op2_isba_RCTVEG_TTE



SURFEX minus ISBA dierence it the lowest model level temperature. Run with (left) and without (right) prognostic TTE. 24h Forecast, base time 10-Jul-2017

Model output diagnostics

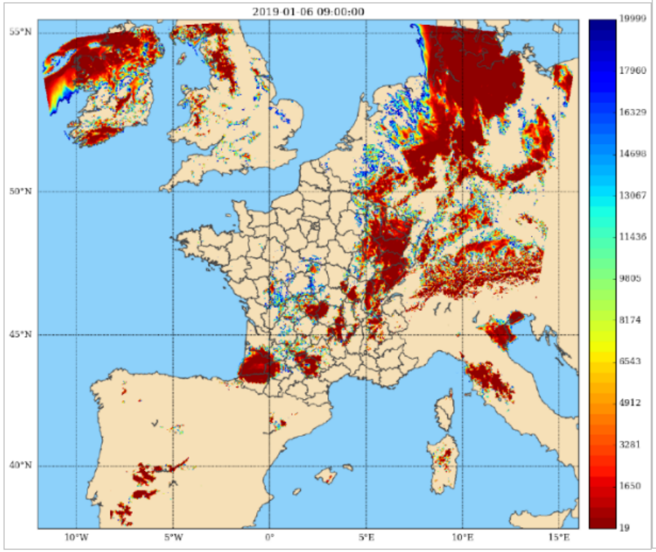
Precipitation type

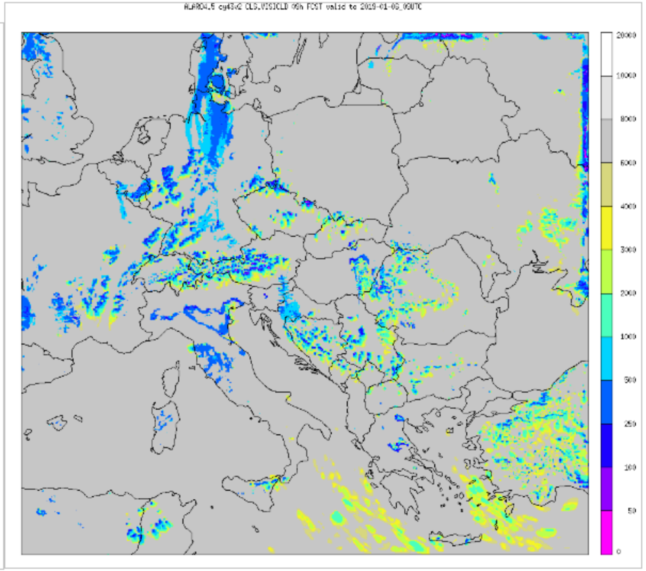
- originally developed in MeteoFrance for AROME, ARPEGE,
- a pack is prepared based on Meteo-France operational branch (CY43T1) for ALARO.
- Testing, validation, tuning is ongoing in Ljubljana by Piotr (midAug-midSep),
- main issue is to tune the limits for graupel/hail as the graupel field differ from AROME one.

Visibility - ALARO and AROME

Implementation of daily updated LAI in AROME (from Surfex ISBA-Ags) (BS 2.5 pm) – link with data assimilation

Visibility (cloud and precipitation based)





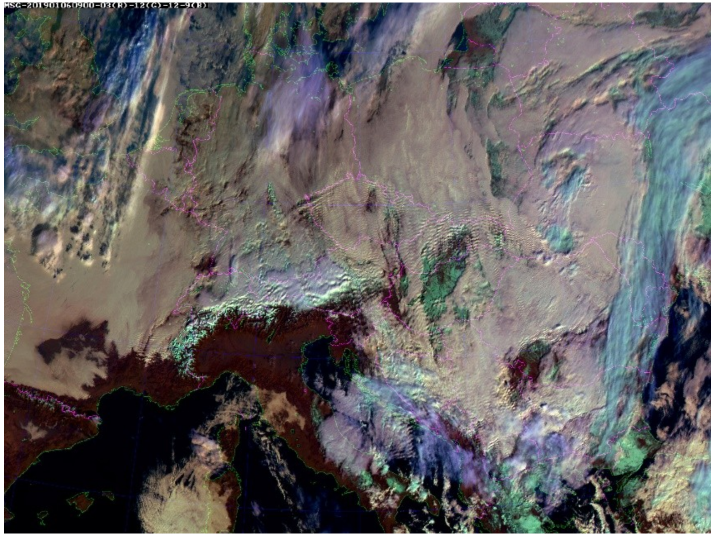


Fig. 3a: Left: 9h visibility (m) forecast from the AROME model valid to 06 January 2019 09 UTC (Piriou et al., 2019). Fig. 3b: Right: Forecast of 1h minimum visibility in clouds (CLS.VISICLD) from ALARO SHMU cy43t2 for the same date and time with default setting. Conditions for fog (visibility < 1km) are in bluish colors.

Visibility (cloud and precipitation based)

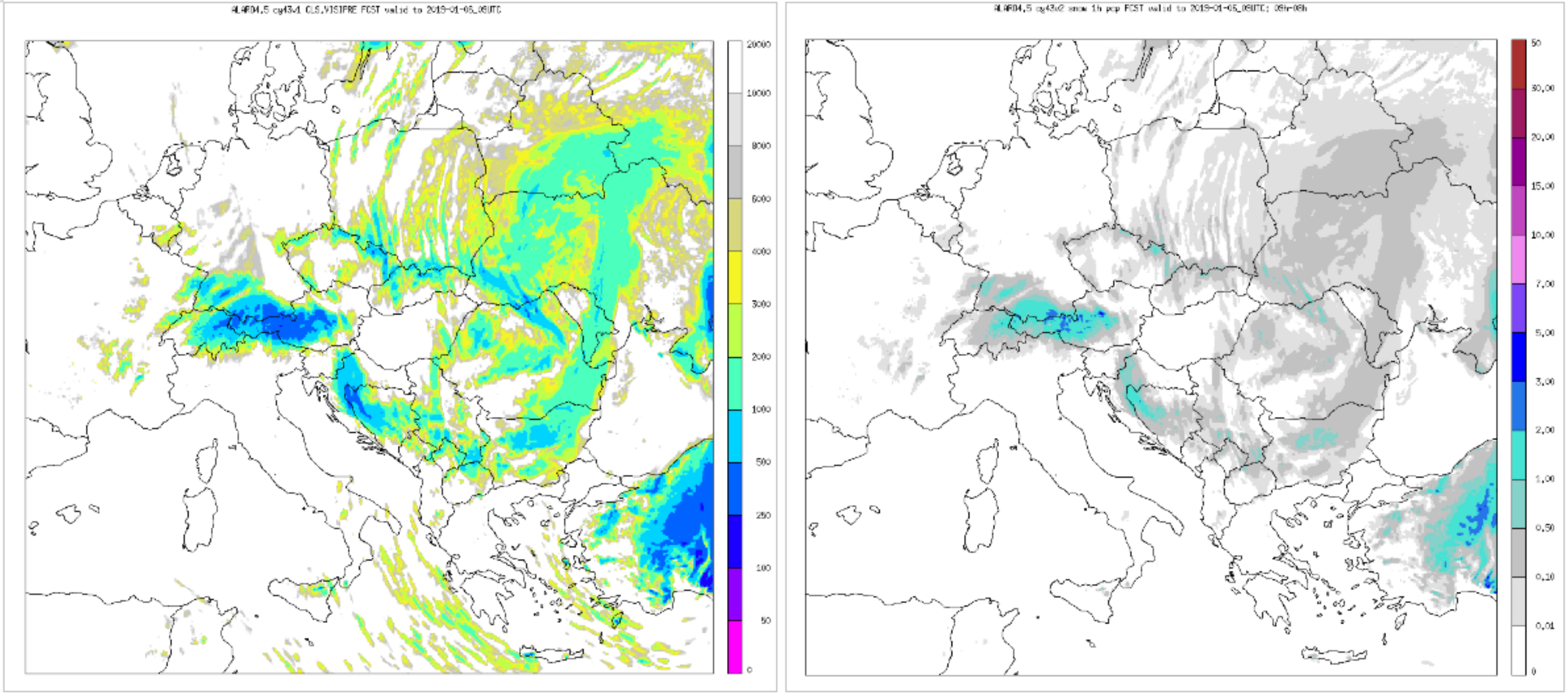
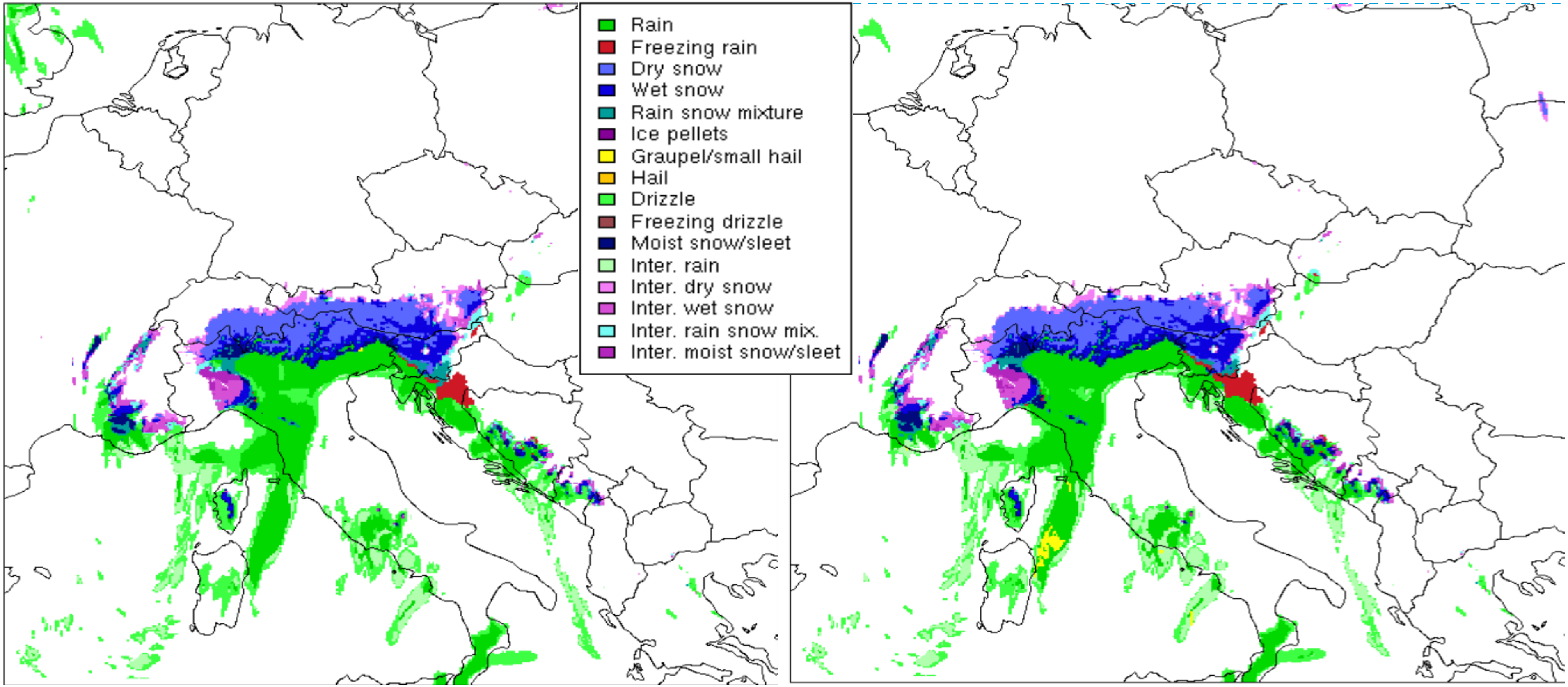


Fig. 6. a: (left) Forecast of 1h minimum visibility in precipitation (CLS.VISIPRE) from ALARO SHMU cy43t2 valid for 06 January 2019 09 UTC. 6b: (right) 1h precipitation forecast for the 08-09 UTC period.

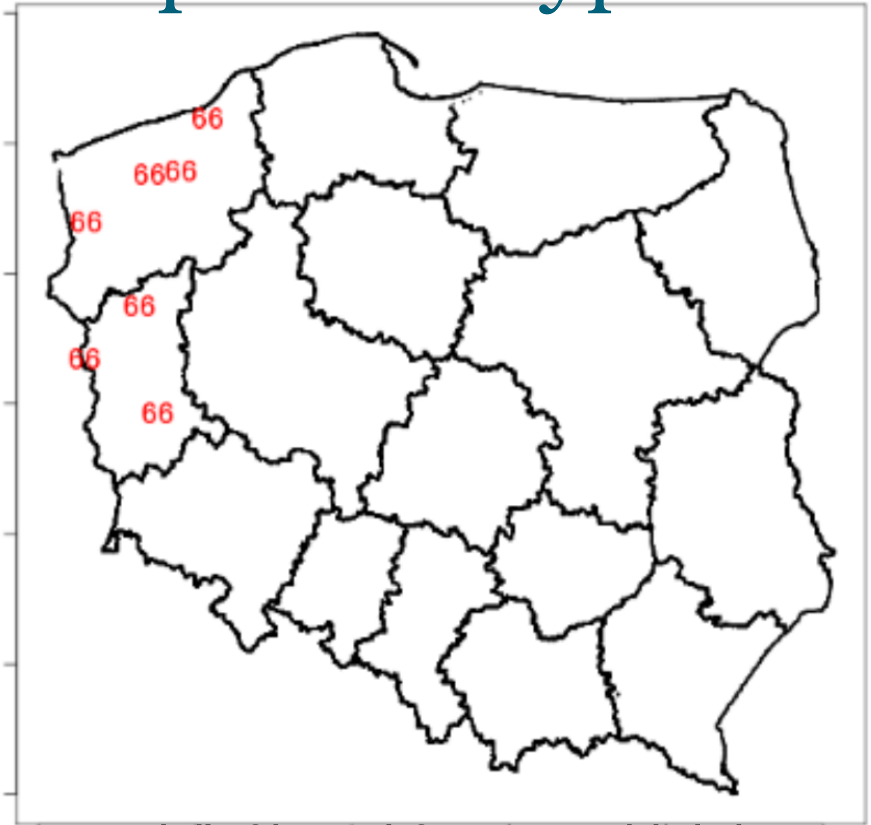
The biggest problem now is how to validate the new forecast fields.

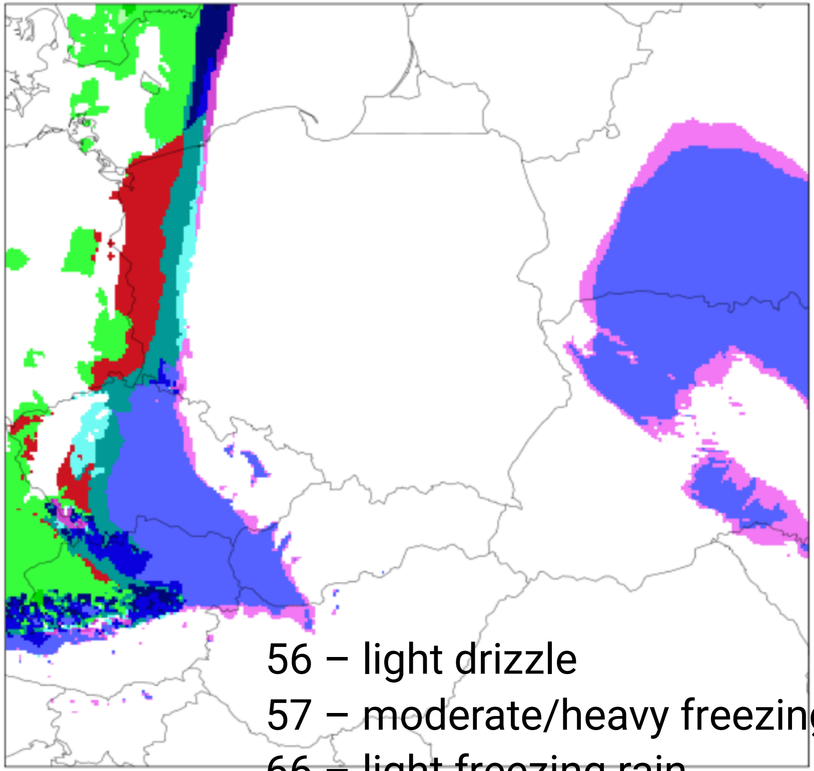
Precipitation types ALARO (Slo and Cro2014)



Precipitation type most frequent (left) and most dangerous (right) on 30.01.2014 20:00 UTC.

Precipitation types ALARO (1.12.2018. 05UTC)

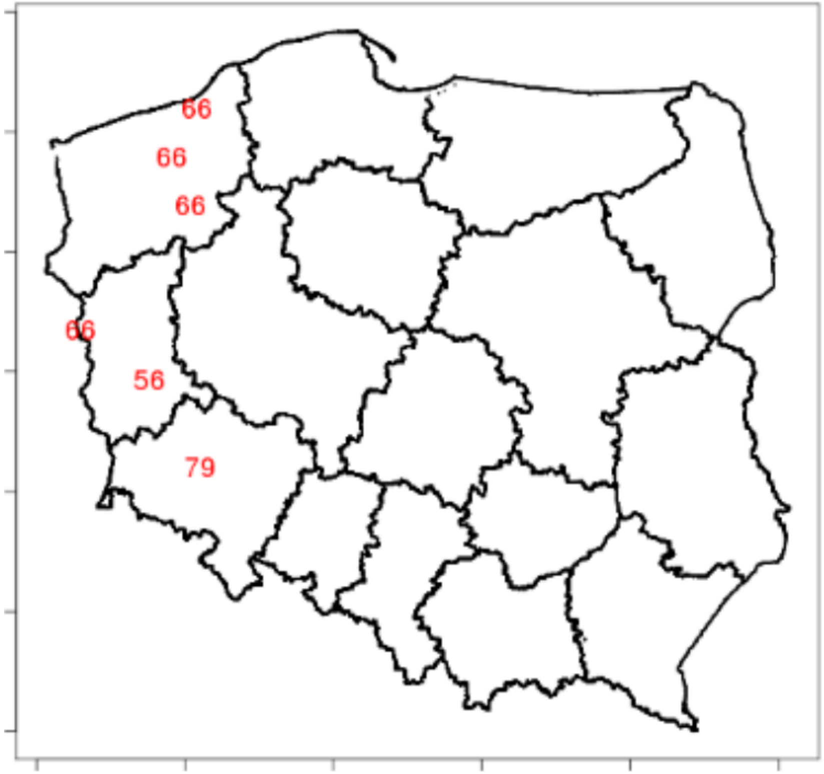


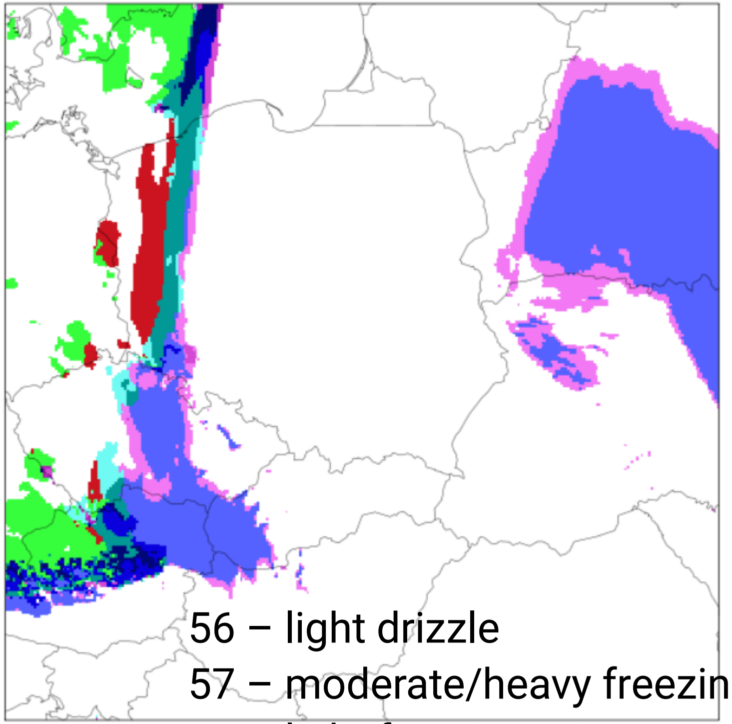


56 – light drizzle
57 – moderate/heavy freezing drizzle
66 – light freezing rain
67 – moderate/heavy freezing rain
79 – ice precipitation

Observed (left) and forecast (right) precipitation types.

Precipitation types ALARO (1.12.2018. 07UTC)

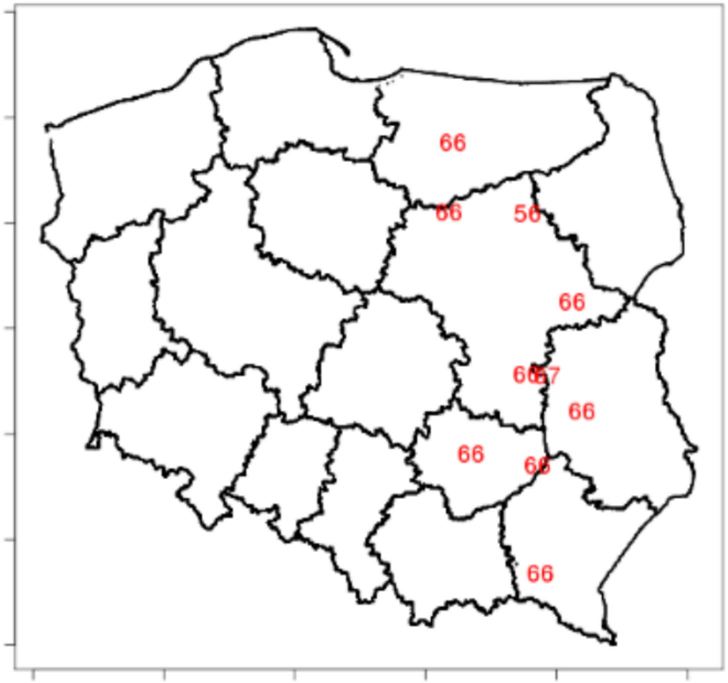


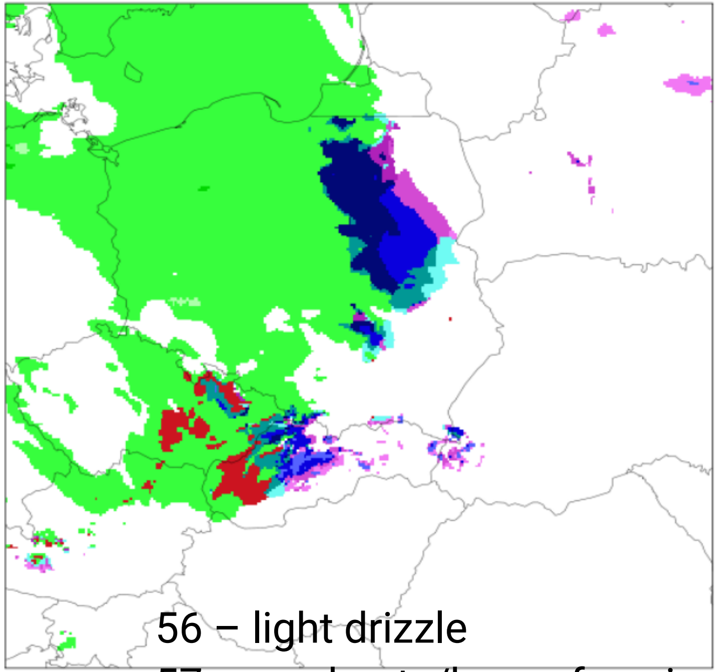


56 – light drizzle
57 – moderate/heavy freezing drizzle
66 – light freezing rain
67 – moderate/heavy freezing rain
79 – ice precipitation

Observed (left) and forecast (right) precipitation types.

Precipitation types ALARO (2.12.2018. 22UTC)





56 – light drizzle
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79 – ice precipitation

Observed (left) and forecast (right) precipitation types.

Precipitation in the Alps

For major (wintertime) precipitation events involving significant flow towards the Alps

AROME 2.5km:

Too strong difference luv side/mountain tops vs. valley/basins

(Probably) too high peaks over mountains

ALARO 2.5km (run with same dynamical setup as AROME above):

Much smoother fields than AROME (but too smooth

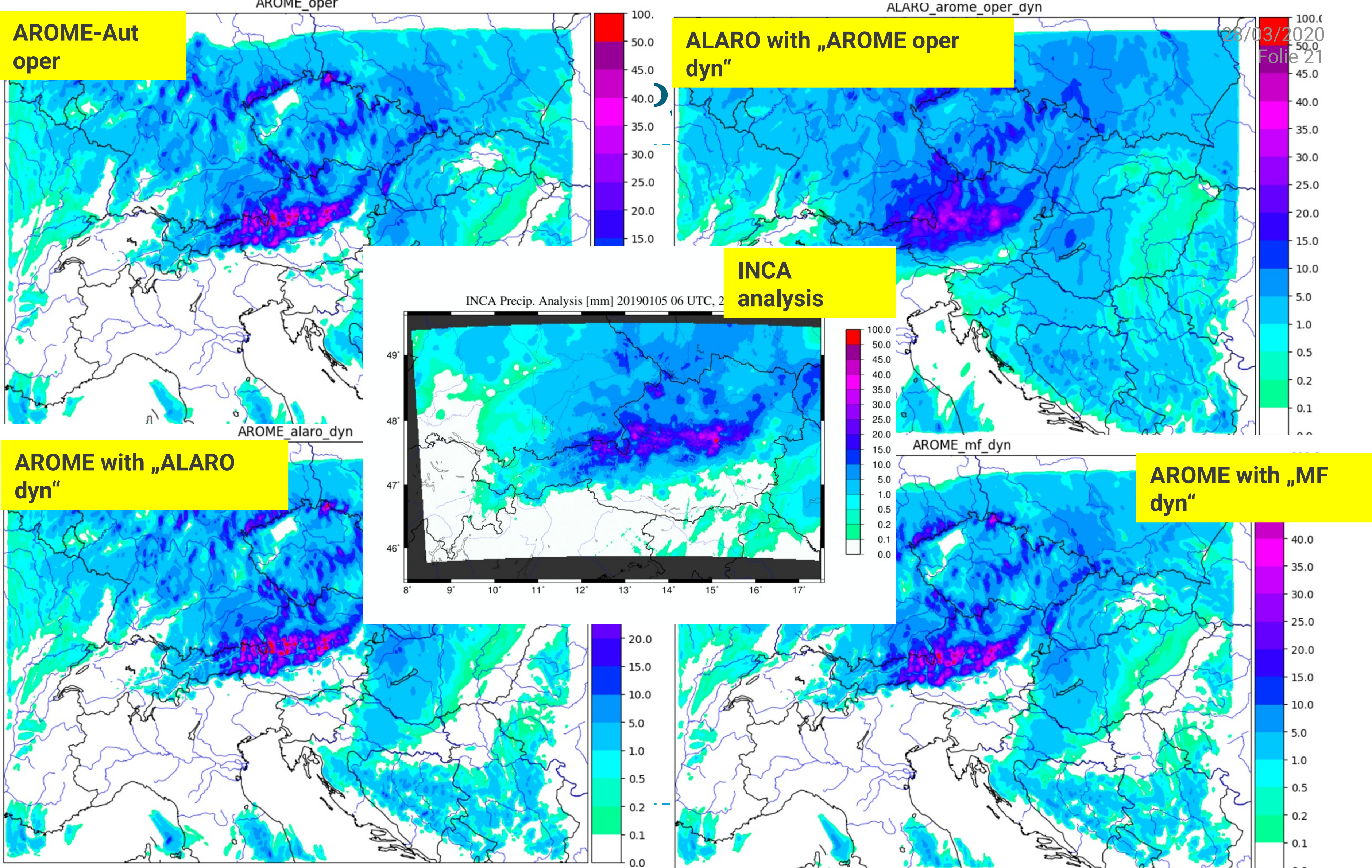
Precipitation spreading too far over the Alps

Goal: Try to understand differences between AROME and ALARO

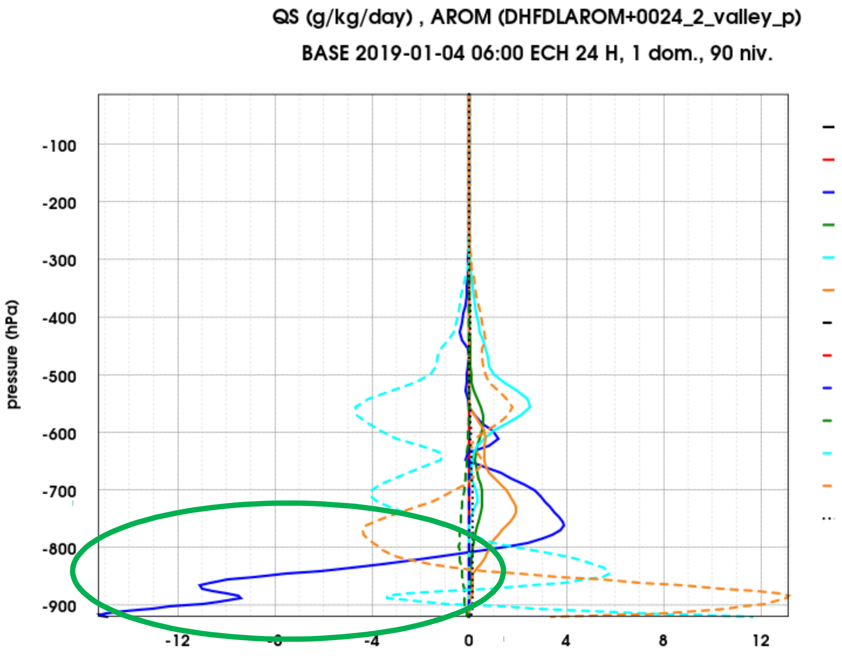
First steps:

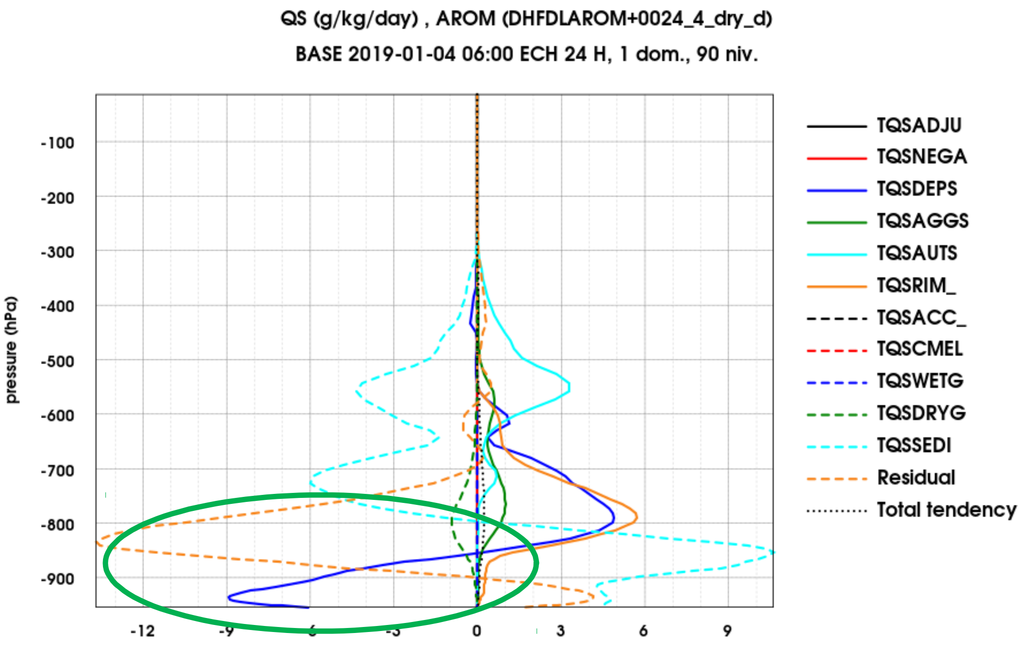
-> running sensitivity tests (diff. Physics, dynamics options)

-> use ddh to identify important contributions for hydrometeor budgets


AROME_oper
AROME-Aut oper
ALARO_arome_oper_dyn
ALARO with „AROME oper dyn“
INCA analysis
INCA Precip. Analysis [mm] 20190105 06 UTC, 2
AROME_alaro_dyn
AROME with „ALARO dyn“
AROME_mf_dyn
AROME with „MF dyn“

Precipitation in the Alps

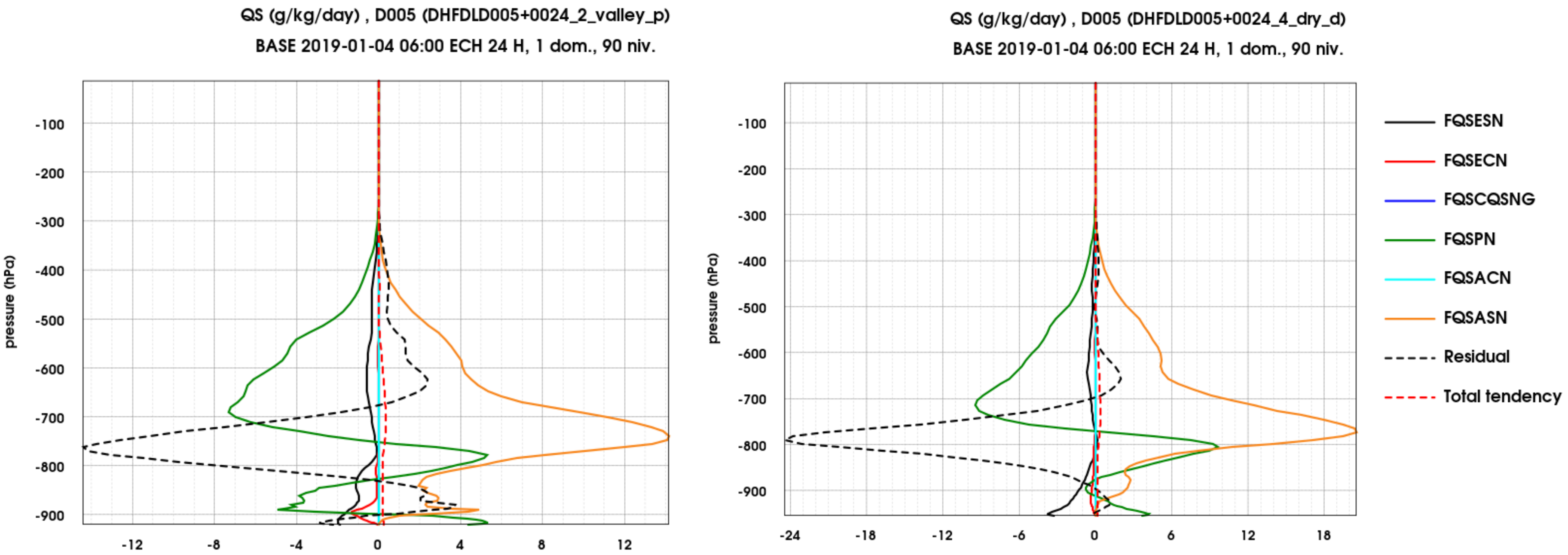




Budget AROME QS – profile for a point and area on lee side

TQSDEPS with strong contribution -> sublimation of snow and graupel in valley

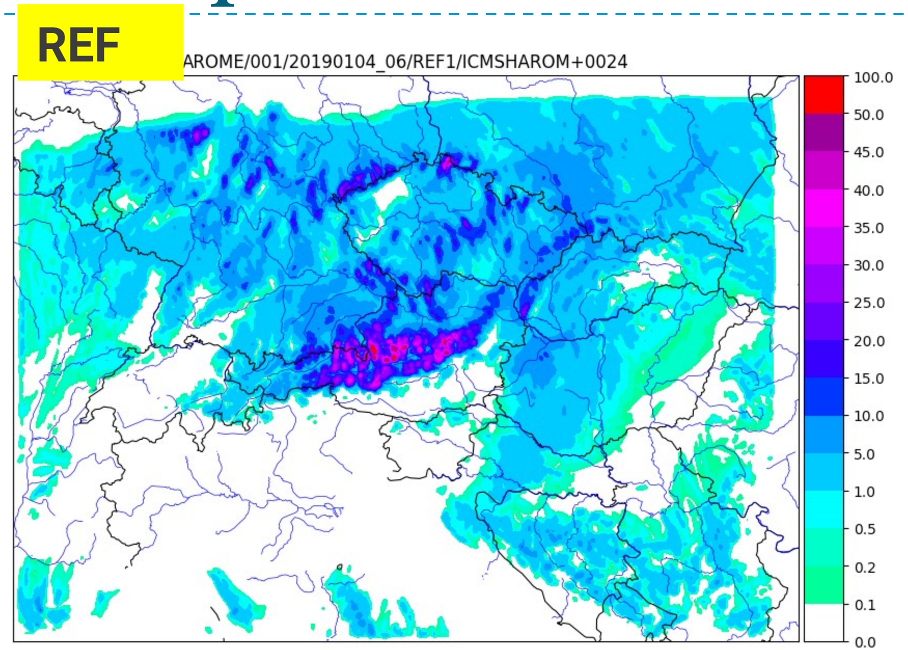
Precipitation in the Alps

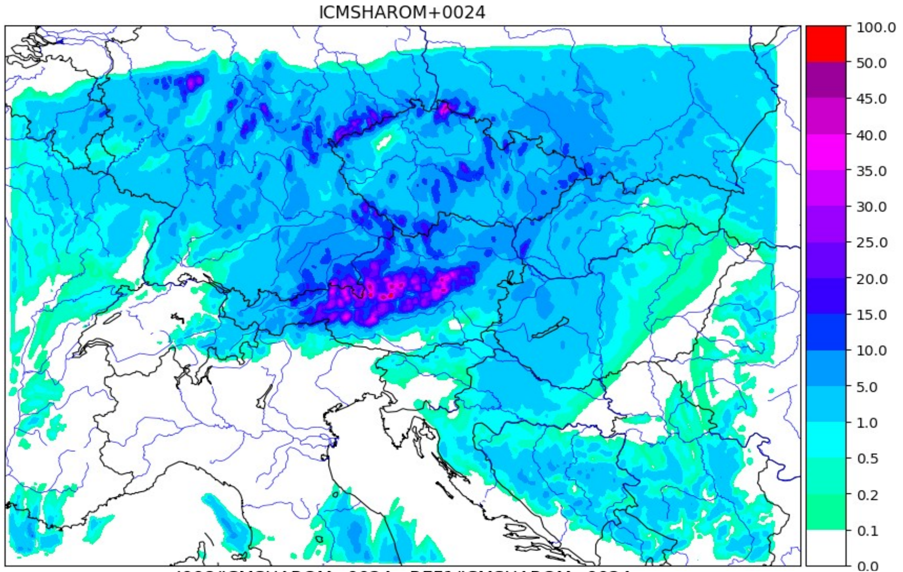


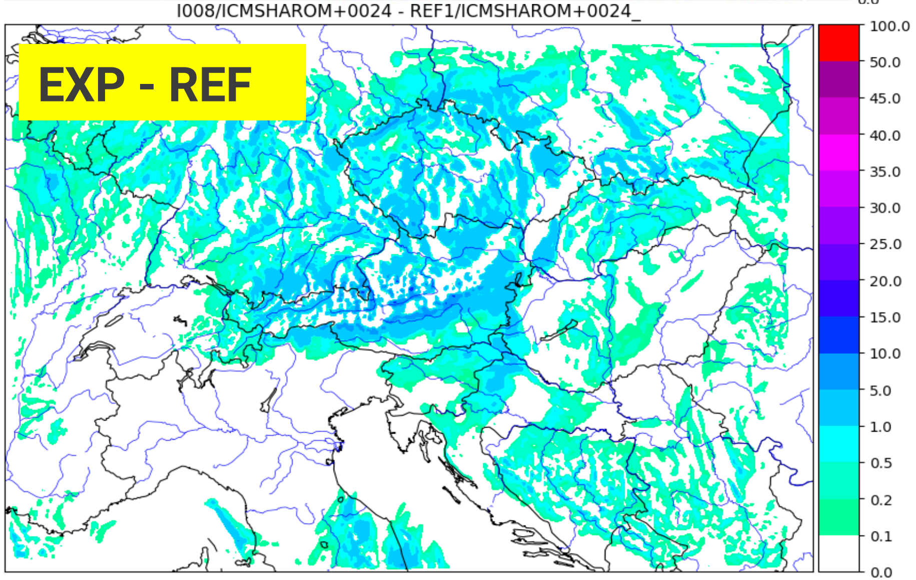
Budget QS ALARO – profile for a point and area on lee side

Difficult to compare single AROME and ALARO microphysical processes, but at least much less sublimation/evaporation (FQSESN) in ALARO in valleys

Precipitation in the Alps





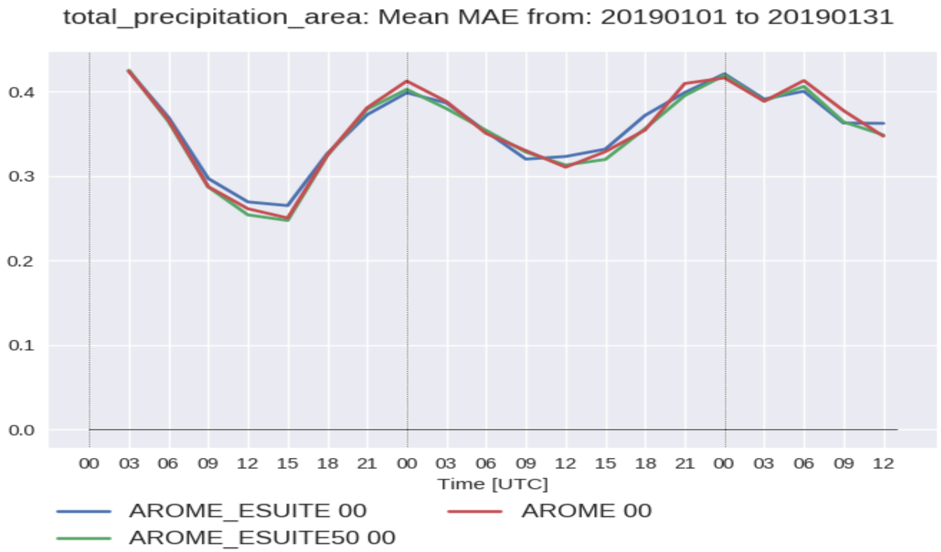


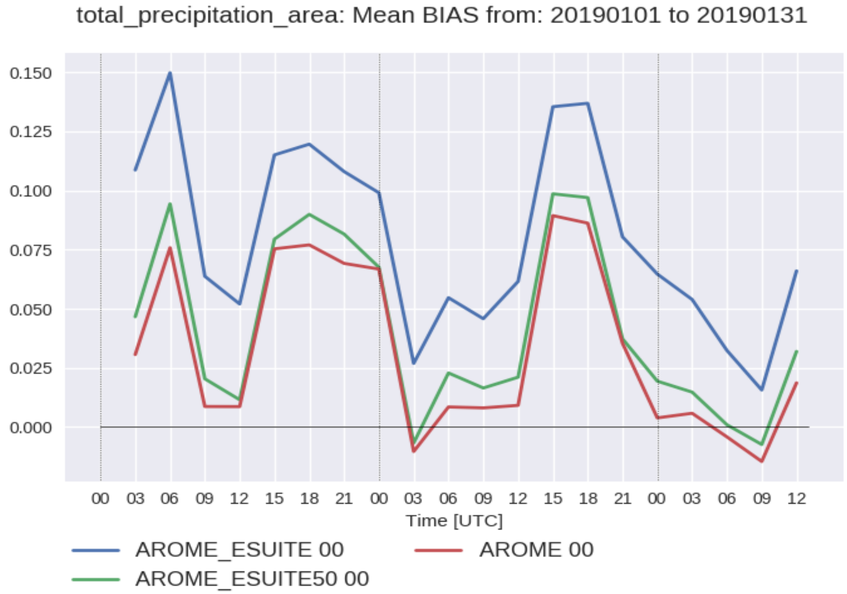
Reducing sublimation of qs + qg in AROME

Reducing RVDEPS und RVDEPG in rain_ice.F90 with „nice" optical effect

Precipitation in the Alps

- 1 month winter was already re-run with modified RVDEPS and RVDEPG
- 1 month summer period will follow
- Results are rather „ambivalent“: overall (for all events and areas) precipitation is slightly increased (-> increasing BIAS, while keeping MAE similar)
- for major events with strong flows over Alps (= the important ones) results are improved





MUSC testbed – working days/training

HIRLAM uses more regularly

MF – Eric Bazile
- issues with input files for AROME (SURFEX format)

Training programme:
- how to prepare and validate experiments
- preparations done at home
- CY46T1 installed on laptop (at least CY43T1)
- CA promised technical help
- how to validate?
- how to prepare experiments?

wiki: HarmonieSystemDocumentation / MUSC

MUSC using the develop branch (CY43) in the git repository

Emily Gleeson and Eoin Whelan have committed a cycle 43 MUSC experiment which runs off the reference HARMONIE code (with no additional src changes).

This experiment can be found in harmonie/util/musc/test/musc_ref.

The 3 input files needed to run an experiment are attached to this page (an atmospheric, surface and pgd file). These need to be copied to harmonie/util/musc/test/musc_ref/input/ before starting an experiment.

Below are instructions to run the default MUSC experiment locally in Met Eireann:

ONLINE?

1. Get MUSC

```
mkdir -p $HOME/harmonie_releases/git
cd $HOME/harmonie_releases/git
git clone https://git.hirlam.org/Harmonie -b develop Harmonie ## This just clones the develop branch
cd Harmonie
git branch
# If you already have a clone of the code but want to update it to the latest, use "git pull" rather than "git branch".
```

2. Create a MUSC experiment. In this example the METIE.LinuxRH7gnu system config file is used and the MUSC experiment name is musc_ref

```
mkdir -p $HOME/hm_musc/test_0001
cd $HOME/hm_musc/test_0001
$HOME/harmonie_releases/git/develop/util/musc/scr/setup_musc.sh -h
$HOME/harmonie_releases/git/develop/util/musc/scr/setup_musc.sh -r $HOME/harmonie_releases/git/develop -c METIE.LinuxRH7gnu -t musc_ref
```

3. Compile and run your experiment (still in $HOME/hm_musc/test_0001)

```
cd $HOME/hm_musc/test_0001
./compile_musc.sh -h
./compile_musc.sh -n 2    # n is the number of parallel make processors
                          # -- pick a sensible number for your laptop/PC/HPC
```

4. Get a copy of the input files

```
cd $HOME
wget https://hirlam.org/trac/raw-attachment/wiki/HarmonieSystemDocumentation/MUSC/muscCY43InputData.tar.gz
gunzip muscCY43InputData.tar.gz
tar -xvf muscCY43InputData.tar
```

5. Run your experiment

```
cd $HOME/hm_musc/test_0001
./run_musc.sh -h
./run_musc.sh -d $HOME/muscCY43InputData    # because we earlier defined the expt to be musc_ref, the files in this sub folder of $HOME/muscCY43Inpu
```

Attachments