Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Prognostic graupel in ALARO

Bogdan Bochenek

DHMZ SHMU ARSO METEO Slovenia OMSZ ZAMG ROMANIA ANM

Previouse work and results

Michiel Van Ginderachter and Joris Van den Bergh

Most important changes:

Evaporation

Collection

Auto-conversion: WBF-process accounts only for creation of graupel

Freezing of rain all goes to graupel

http://www.rclace.eu/File/ALARO/alaro1_wd14vi/alaro1wd_MvG_microphys_may14.pdf

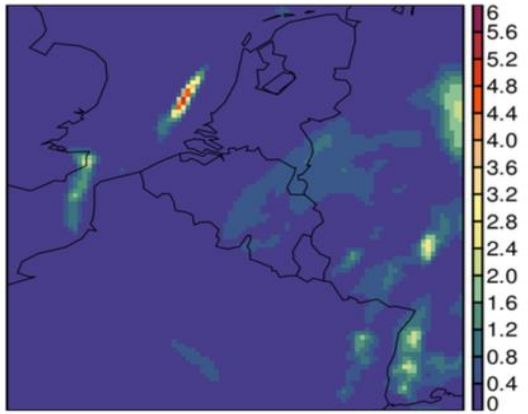
Previouse work and results

Michiel Van Ginderachter and Joris Van den Bergh

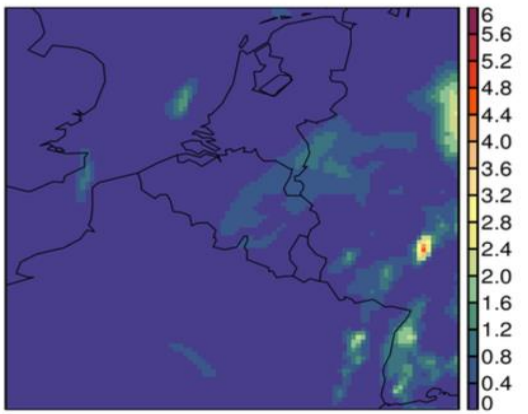
First preliminary tests

Winter SNOW case

TOTAL PRECIPITATION
WITH DIAGNOSTIC GRAUPEL
3H ACC



TOTAL PRECIPITATION
WITH PROGNOSTIC GRAUPEL
3H ACC



Ljubljana 2017

Based on the work of Michiel Van Ginderachter and Joris Van den Bergh that was done on ALADIN code cy38, prognostic graupel was phased into ALADIN code cy43t2 (and cy45)

arpifs/adiab/cpg.F90
arpifs/adiab/cputqy.F90
arpifs/namelist/namphy.nam.h
arpifs/phys_dmn/accoll.F90
arpifs/phys_dmn/acevmel.F90
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arpifs/phys_dmn/mf_phys.F90
arpifs/phys_dmn/accsu.F90
arpifs/setup/su0phy.F90

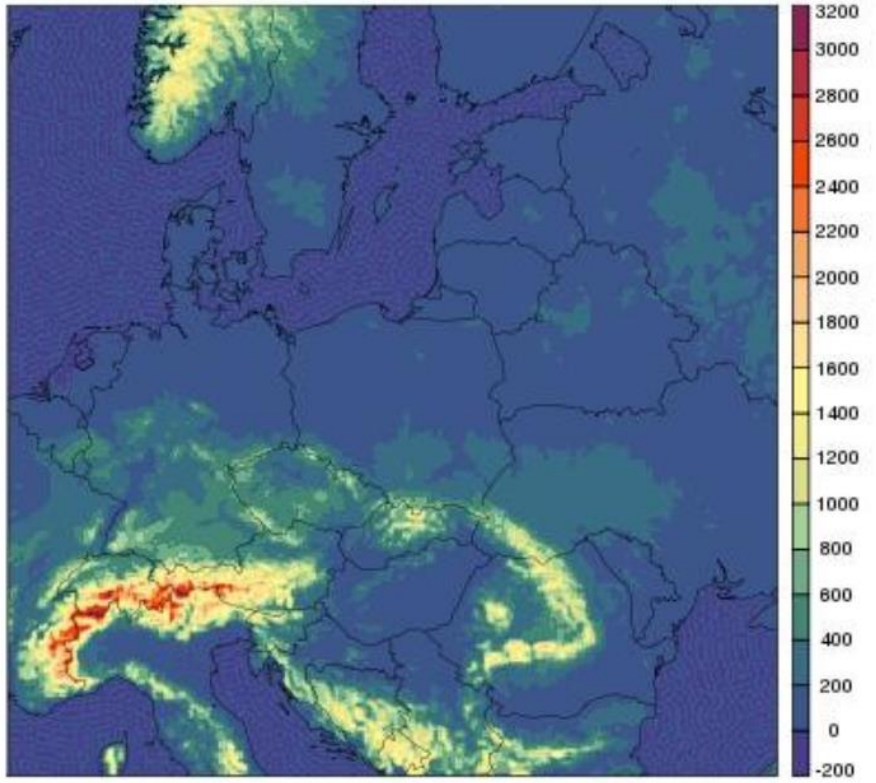
Ljubljana 2017

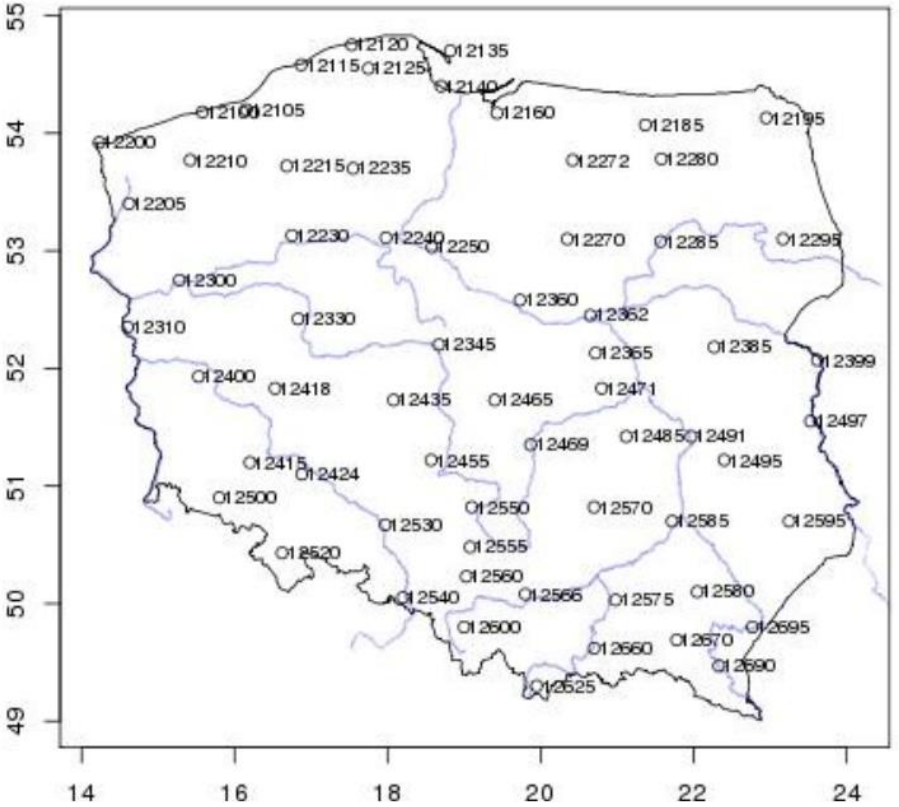
Domain of model:
resolution: 7.4 km
vertical levels: 60
points: 309x309 (320x320)
start of forecast: 00 UTC

Observational data: 61 stations in Poland
time of experiment: 2013

Verification:
Point to point verification, closest node
of model domain for all synoptic stations.

Ljubljana 2017





Domain for experiments (left) and synoptic stations used for verification (right)

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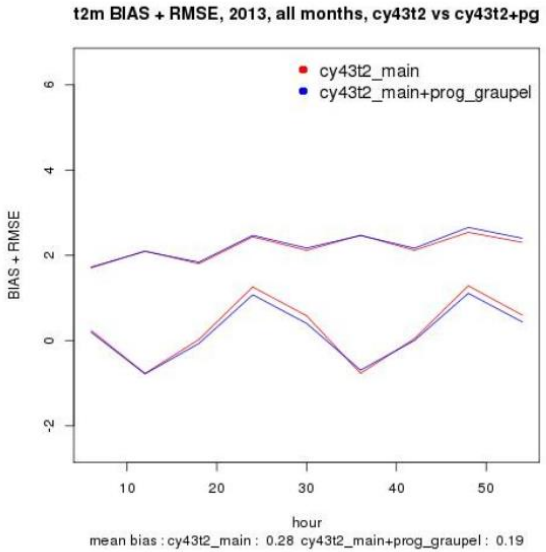
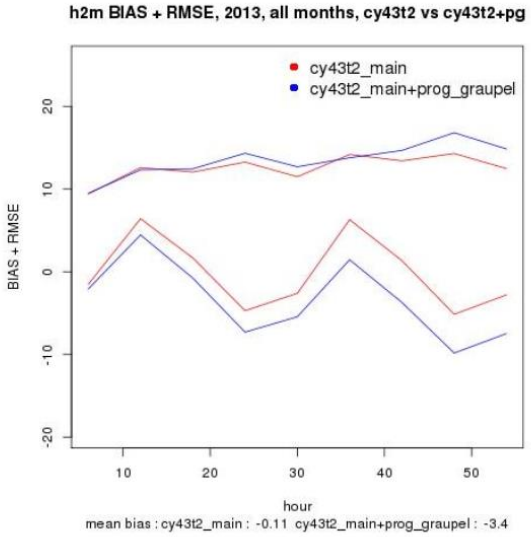
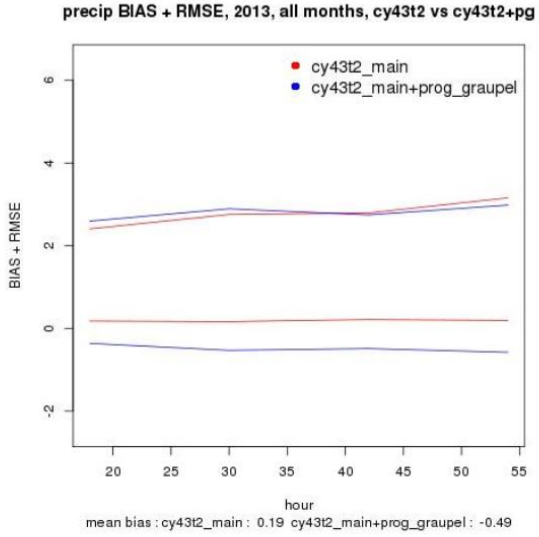
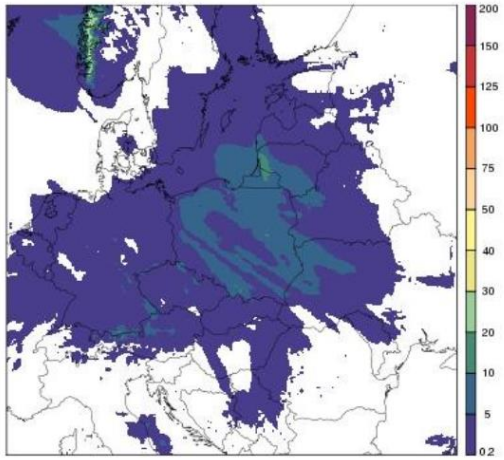
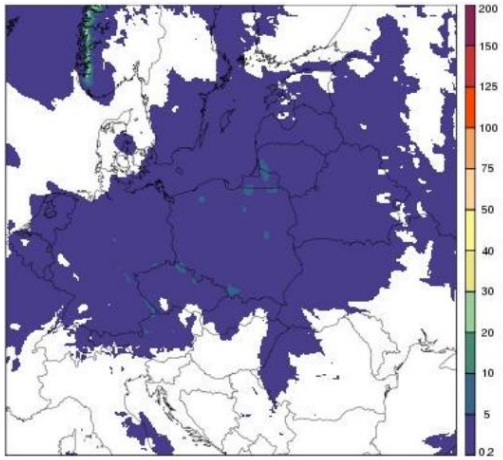
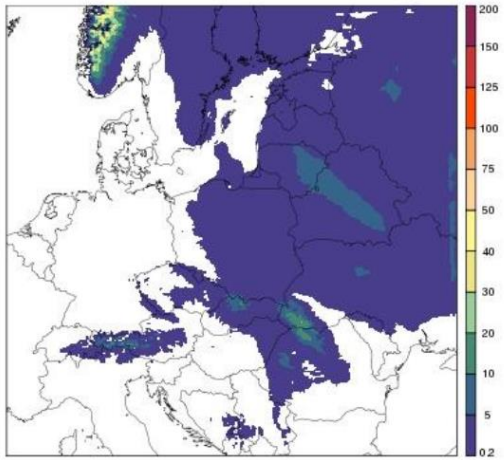
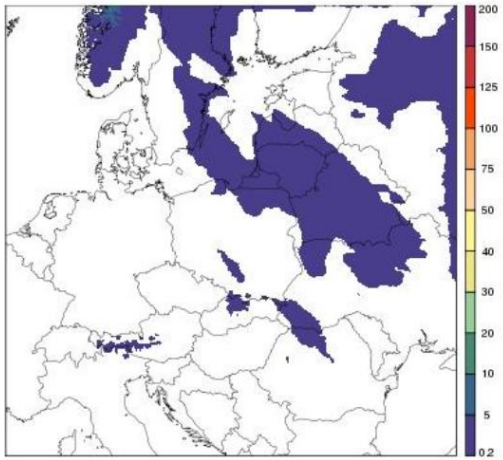

t2m BIAS + RMSE, 2013, all months, cy43t2 vs cy43t2+pg
cy43t2_main
cy43t2_main+prog_graupel
BIAS + RMSE
hour
mean bias : cy43t2_main : 0.28 cy43t2_main+prog_graupel : 0.19


h2m BIAS + RMSE, 2013, all months, cy43t2 vs cy43t2+pg
cy43t2_main
cy43t2_main+prog_graupel
BIAS + RMSE
hour
mean bias : cy43t2_main : -0.11 cy43t2_main+prog_graupel : -3.4


precip BIAS + RMSE, 2013, all months, cy43t2 vs cy43t2+pg
cy43t2_main
cy43t2_main+prog_graupel
BIAS + RMSE
hour
mean bias : cy43t2_main : 0.19 cy43t2_main+prog_graupel : -0.49

	cy43t2_main	cy43t2_main + prognostic graupel
Rain vs Rain		
Snow vs Snow		

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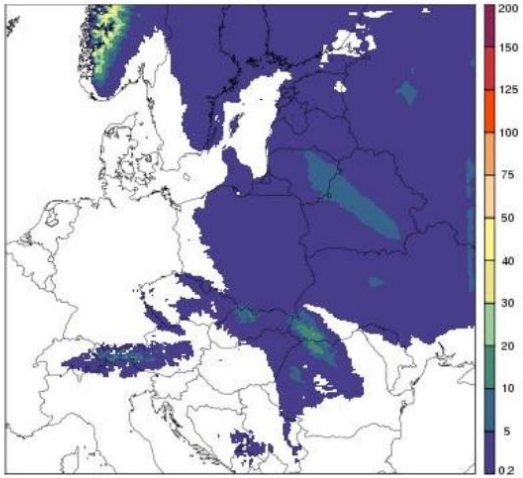
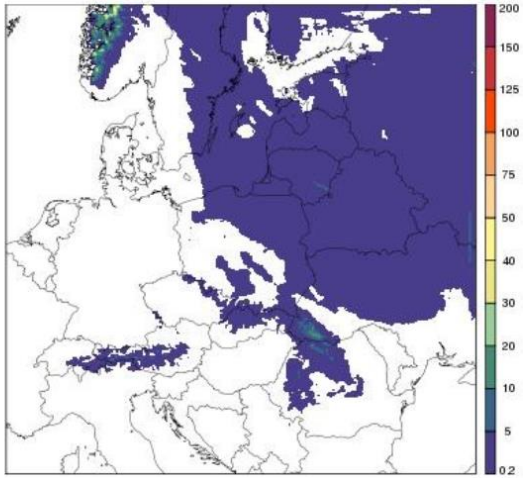
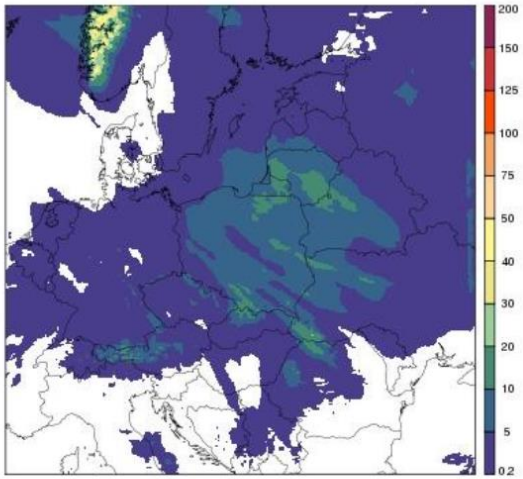
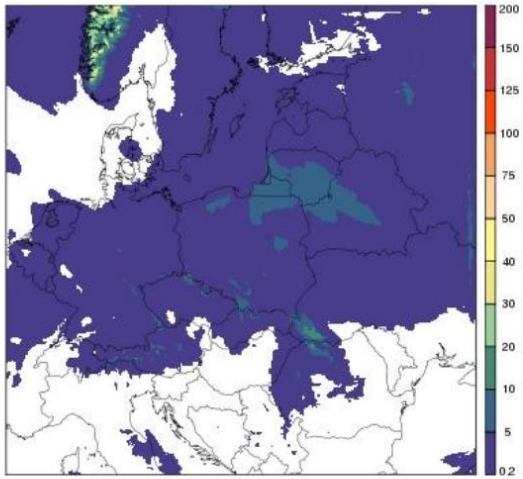
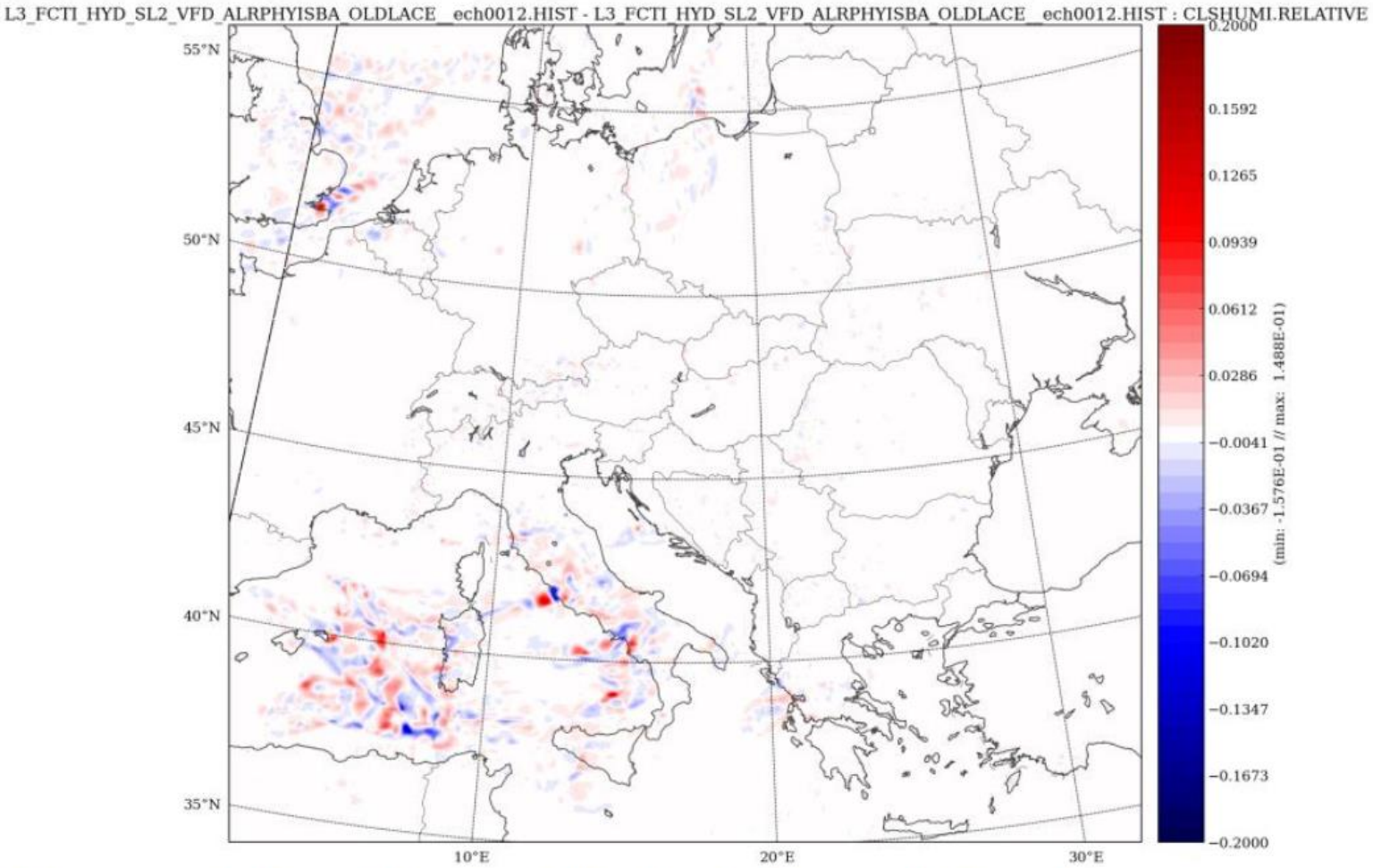
Snow vs Graupel	SURFPREC.NEI.GEC 2013/1/3 z0:0 +30h 	SURFPREC.GRA.GEC 2013/1/3 z0:0 +30h 
Total vs Total	SURFPREC.EAU.GEC 2013/1/3 z0:0 +30h 	SURFPREC.EAU.GEC 2013/1/3 z0:0 +30h 

Problem with phasing cy46



Differences in 2m relative humidity after 12 hours of integration

Problem with phasing cy46

Olda's phasing report

-fast-transcendentals

Generally if we put some statement into vector loop containing transcendental functions the vectorisation will be broken and it will change also result. In our case this braking statement should be even term IF (LGRAPRO). But, it may be also f.e. WRITE statement. It drifted us during investigation process to misleading suspicion of memory overwriting.
A example how vectorisation is broken by term statement.:

```
!DEC$ IVDEP
DO JLON=KIDIA,KFDIA
  ZHSEFN=ZAUTEFS*TSPHY*(1.0_JPRB-EXP(-(PQIST(JLON)/ZQICR)**2))
  ...
ENDDO
```

Problem with phasing cy46

A example how vectorisation is broken by term statement.:

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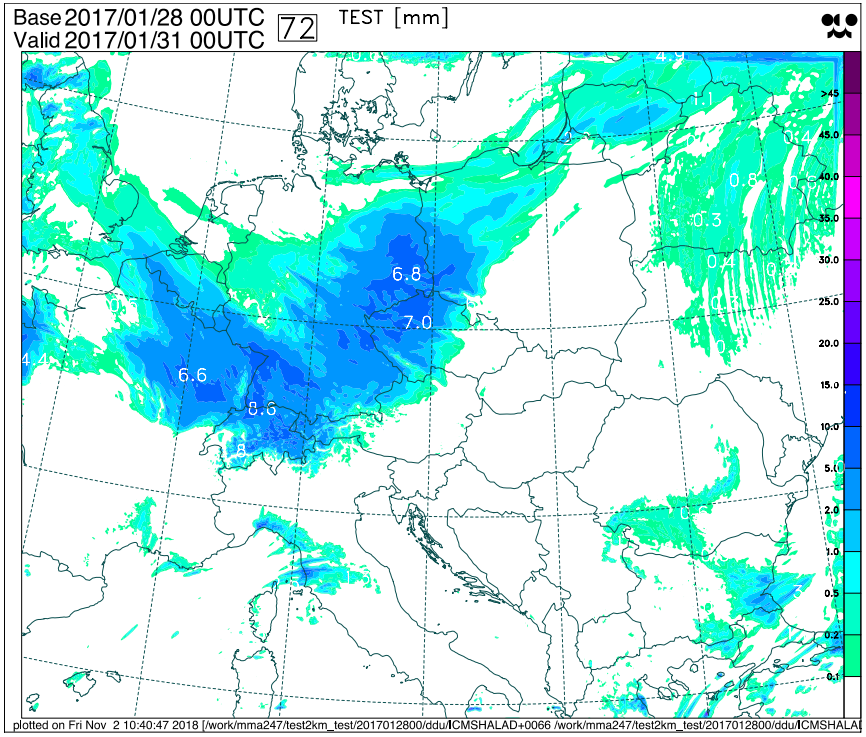
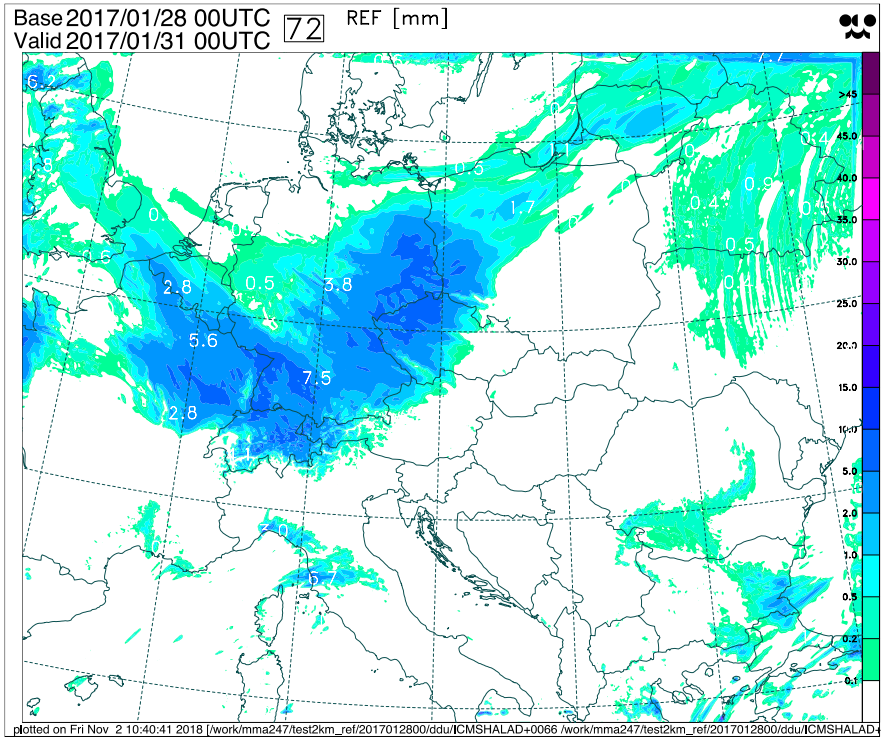
  ...
ENDDO

!DEC$ IVDEP
DO JLON=KIDIA,KFDIA
  ZHSEFN=ZAUTEFS*TSPHY*(1.0_JPRB-EXP(-(PQIST(JLON)/ZQICR)**2))
  IF (LGRAPRO) THEN
    ZHSEFG=ZAUTEFG*TSPHY*(1.0_JPRB-EXP(-  (PQIST(JLON)/ZQICR)**2))
    ...
  ELSE
  ...
 ENDDO
```

Problem with phasing cy46

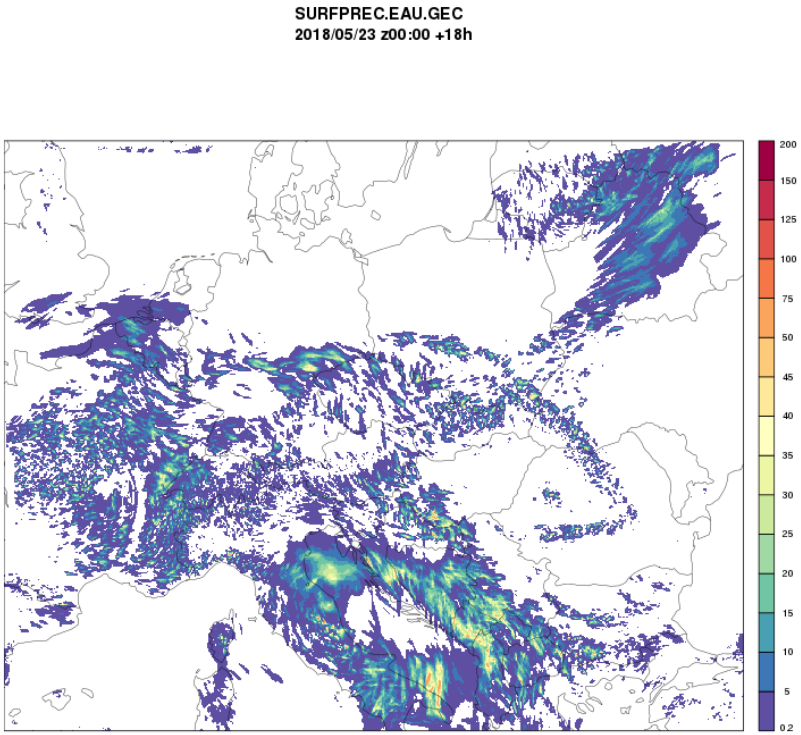




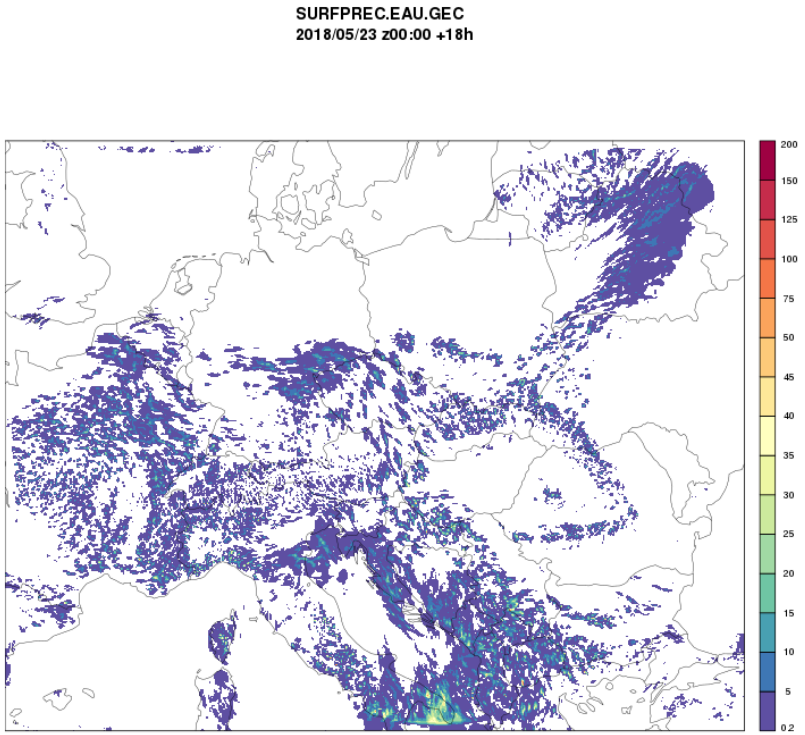
No significant differencess in precipitation fields after 72 hours of forecast

Praha 2018

Problem with less precipitation on surface

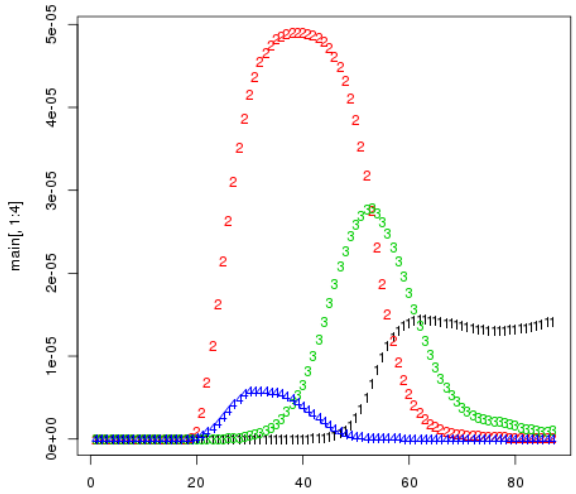


ALARO cy43 -12 h precipitation

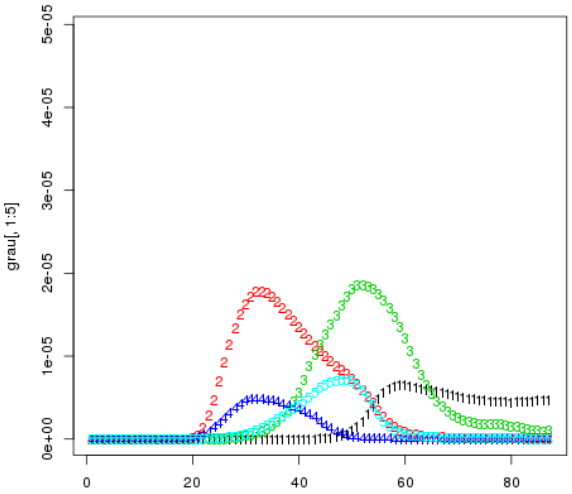


ALARO cy43 + prognostic graupel - 12 h precipitation

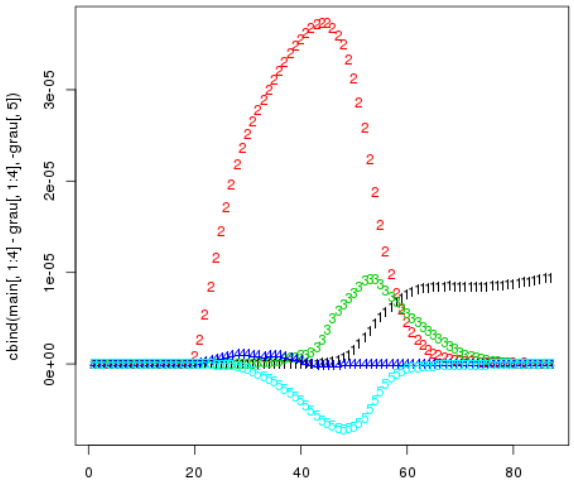
Praha 2018



ALARO cy43



ALARO cy43 +
prognostic graupel



difference

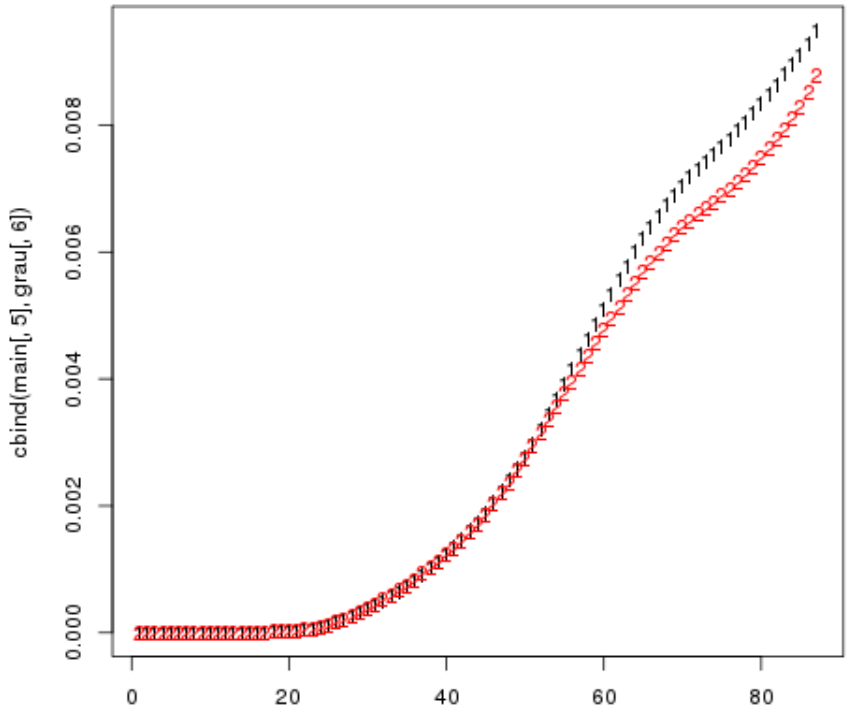
Mean profiles for:

1) Rain - black
2) Snow - red
3) Liquid Water - green
4) Ice Crystals – dark blue
5) Graupel – light blue

Praha 2018

With prognostic graupel we have less precipitation on surface and less water vapur in results.

After few timesteps there is more hydrometeors with prognostis graupel turned on, but later it is opposite.



Water vapour – mean profile

1) ALARO
2) ALARO + prognostic graupel

Further investigation

Two possible explanations:

1) Bug in the code
2) Retuning of parameters needed

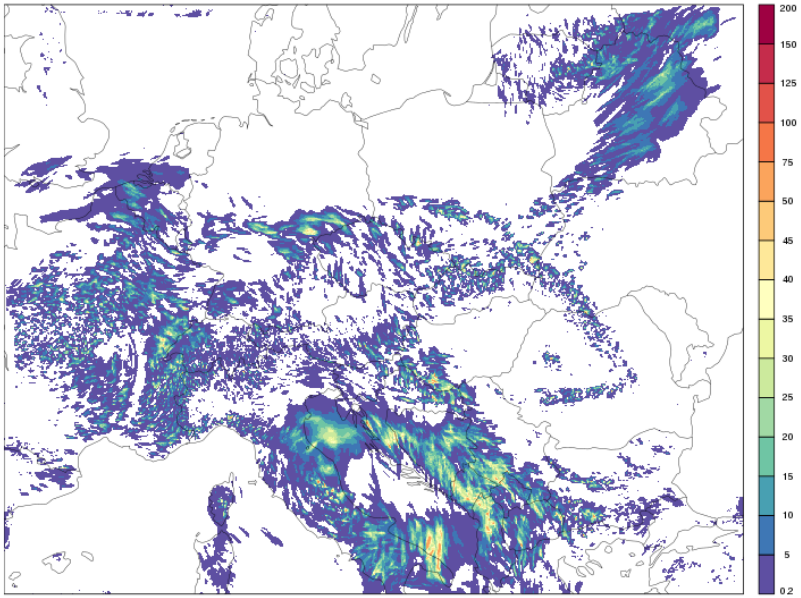
Several bugs were found in the code, with minimal impact of results.

Different processes works fine separately, but when combine together we have missing precipitation.

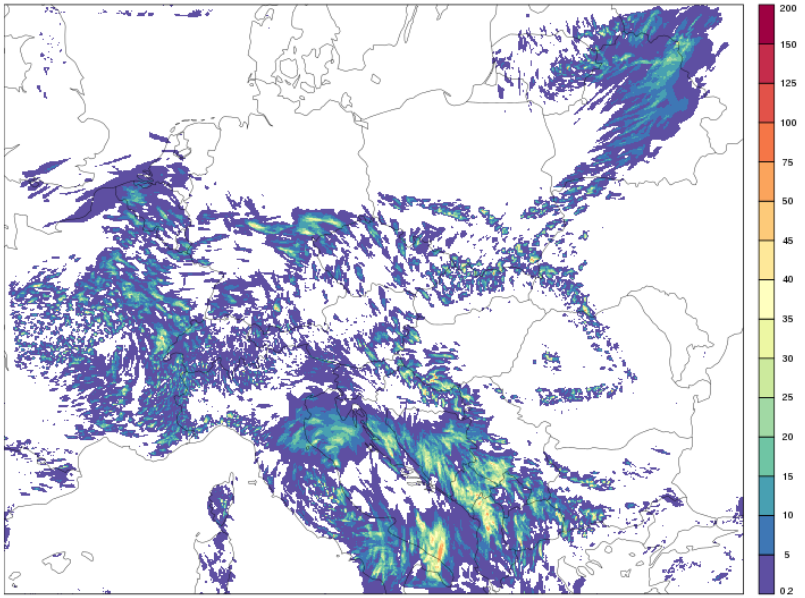
Several test made to check retuning.

Further investigation

Turn off WBF for graupel



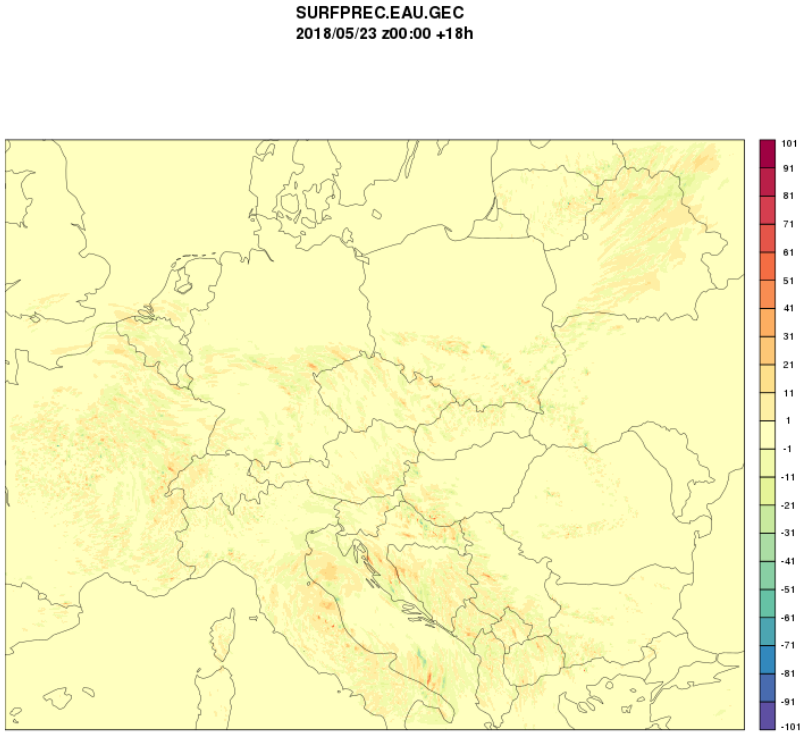
ALARO



ALARO + prognostic graupel

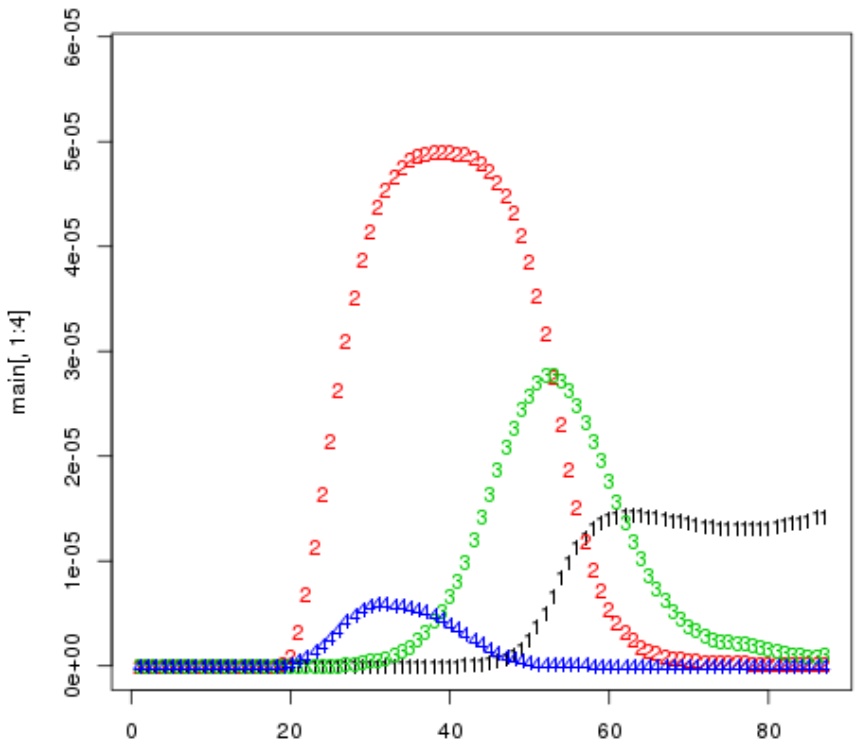
Further investigation

Turn off WBF for graupel

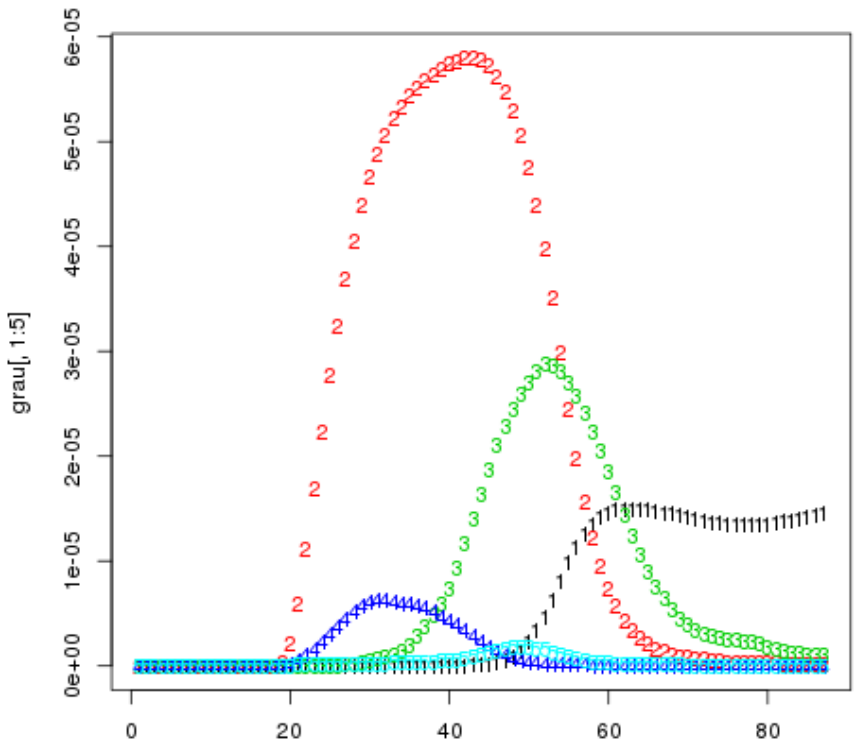


Total precipitation difference

Further investigation



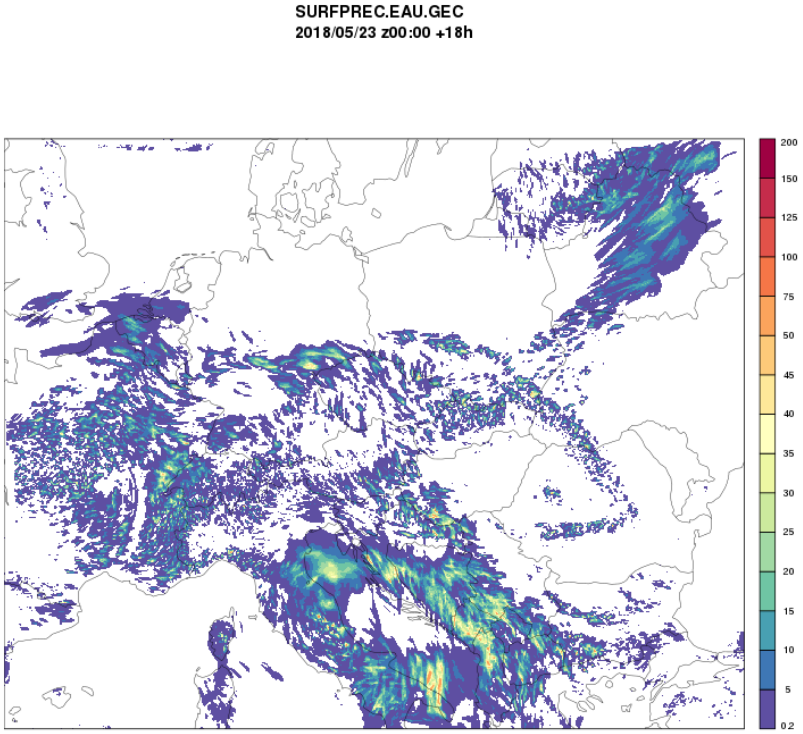
ALARO cy43



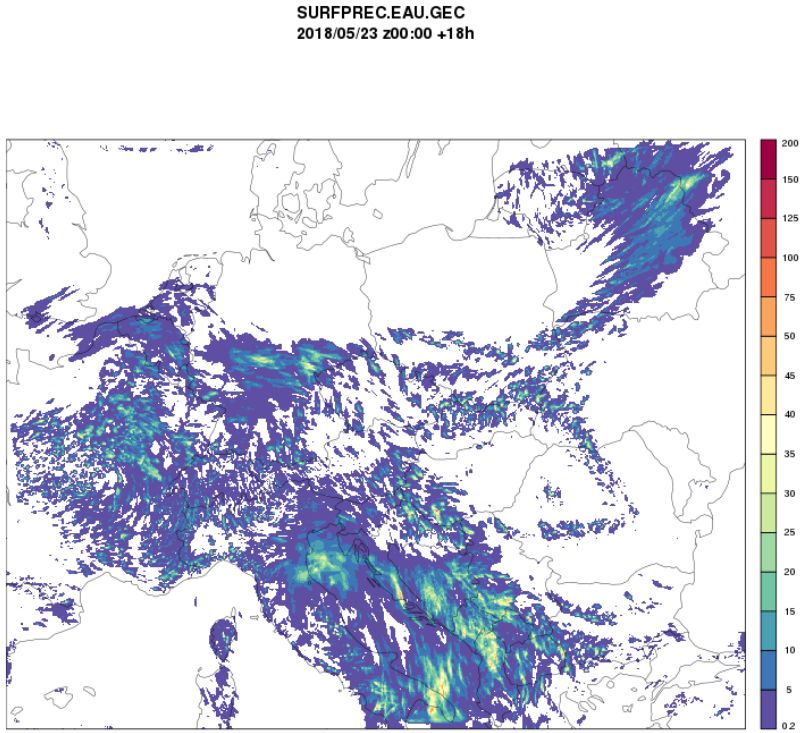
ALARO cy43 +
prognostic graupel

Further investigation

Turn off WBF for graupel and snow



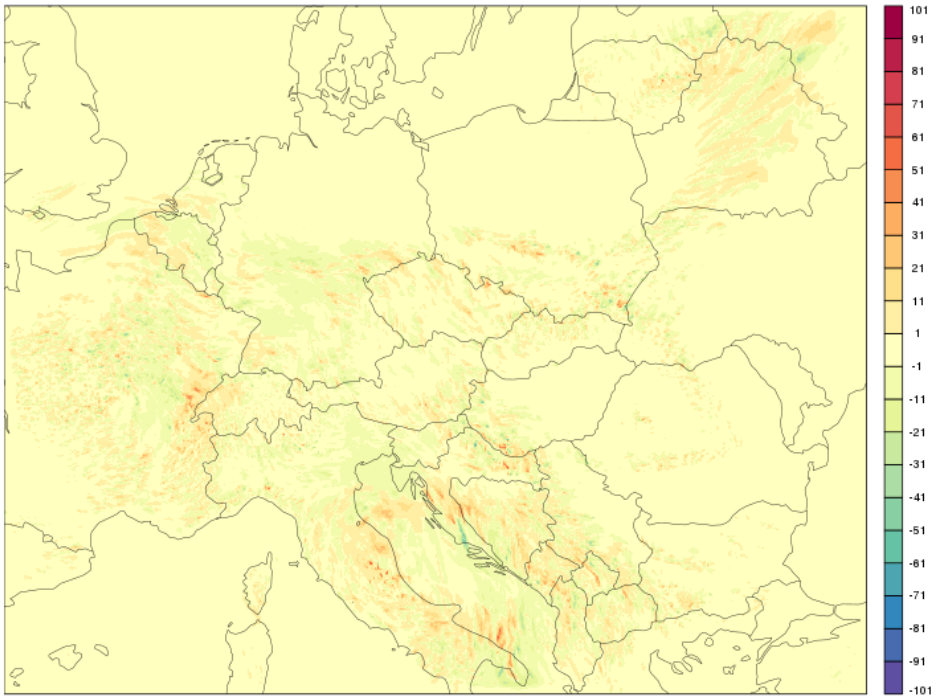
ALARO



ALARO + prognostic graupel

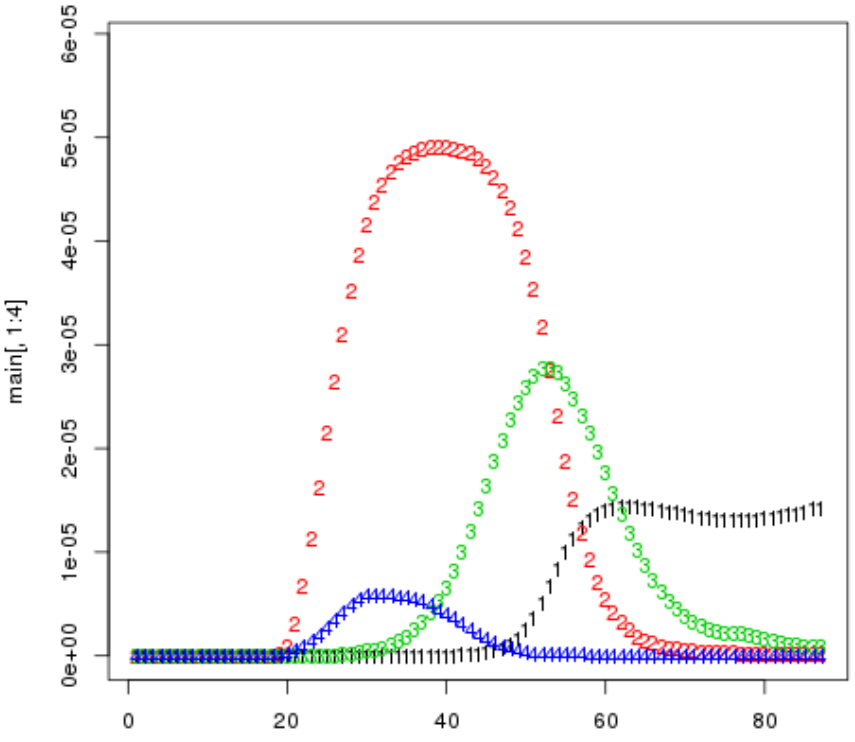
Further investigation

Turn off WBF for graupel and snow

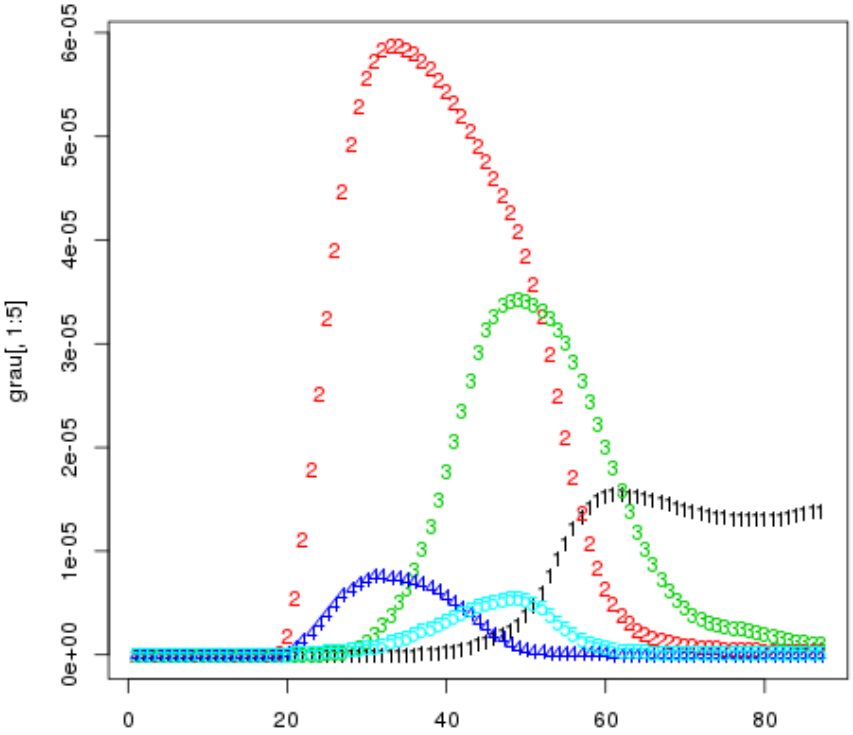


Total precipitation difference

Further investigation



ALARO cy43



ALARO cy43 +
prognostic graupel

Conclusions:

Continuation on checking the code.

Further test should be done, for longer periods, to check impact on verification scores.

Increase of computational time ~ 5% on 40 nodes, for 2 km CHMI ALARO

Retuning of tunable parameters? Adding new tunable parameters?

Cleaning the code.

Thank you!

Any ideas?