Update on AROME-RUC (ZAMG)

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Outline

- Observation impact
- Spin_up
- wind profiler
- radar + bator cy40t1->cy43t2
- Assimilation of private weather stations

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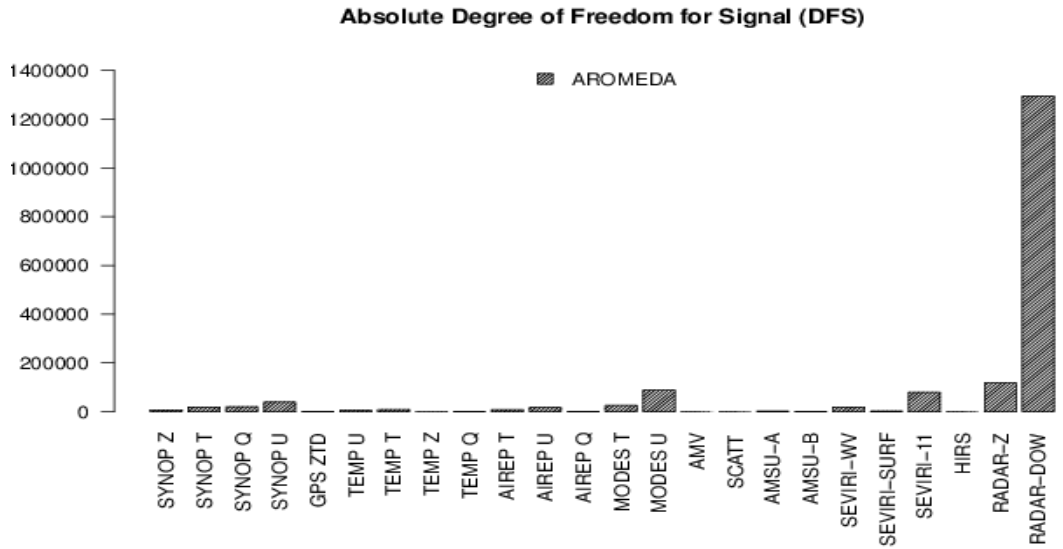
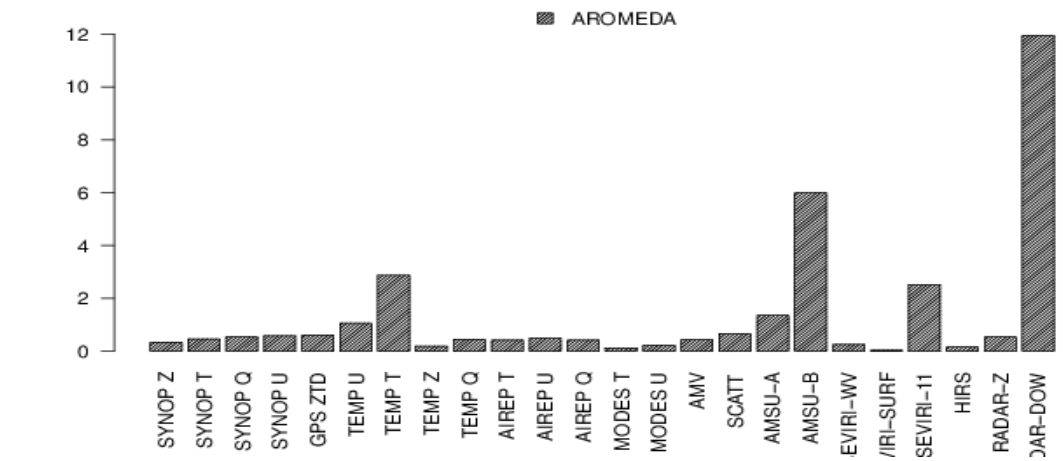
DFS in AROME-RUC (old setting noVARQC, larger rejection limit for DOW):





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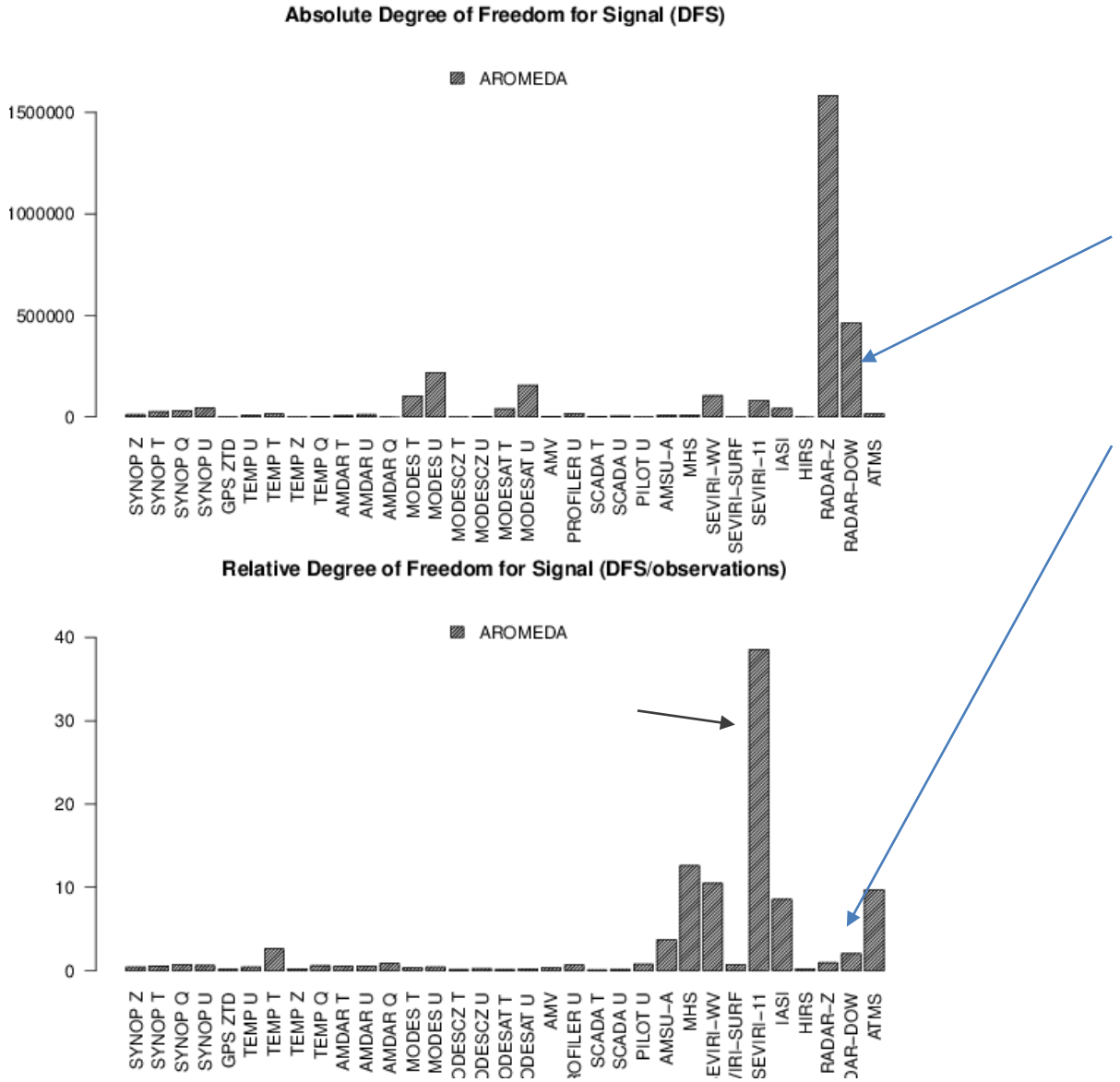
DFS in AROME-RUC current setting:



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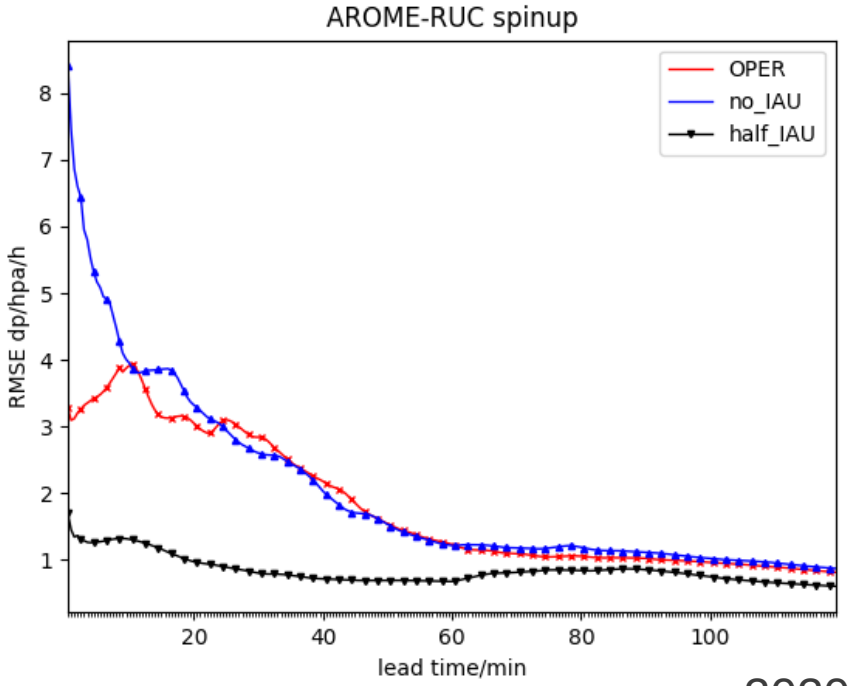
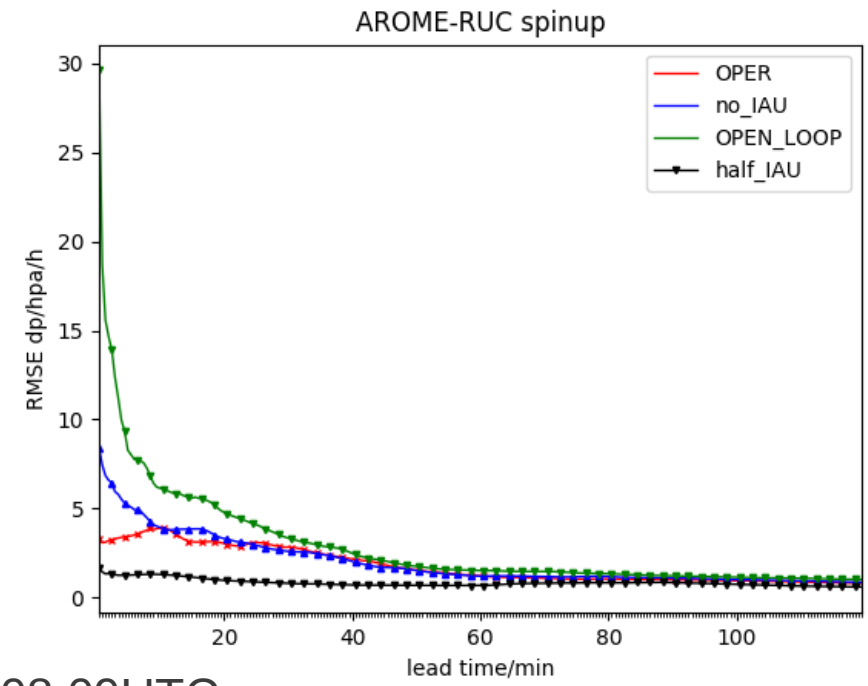
Spin-Up





20200908 09UTC

- -45min to 0 min IAU is very efficient in filtering (black); accuracy?
- no_IAU: directly started from Minimization output
- 2x IAU (OPER) still better than without IAU especially till +20min,
  but not so much at +1h
- Open loop has most spin-up issues as there is interpolation of FG 2.5 -> 1.2km
- Most of the spin up until +60min gone

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Assimilation of wind profilers / wind turbines/ SODAR

- KNMI reported problem with height attribution (Videomeeting, no details)

- Observation is function of height, but model needs pressure
  ->BATOR ecriture: „conversion altitude en pression si necessaire“
  assumes standard atmosphere, which can be far from reality especially in PBL
  error of 20m and more

- Take pressure/temperature/height relation from FG instead (barometric equation)
  -> coded in hretr.F90/hretr_conv.F90 (cy43t2) (see LACE forum)
  -> KNMI has different solution in hop.F90
- Depending on FG, which is not so nice, if FG is incorrect, but assumption of standard atmosphere can deviate even more (T inversion etc.)

- Profiler data from OPLACE -> adaptation of param.cfg „WARNING - template inconnu“
  in BATOR many different bufr templates

- blacklist VAD profiles in LISTE_NOIR_DIAP
- SODAR to obsoul

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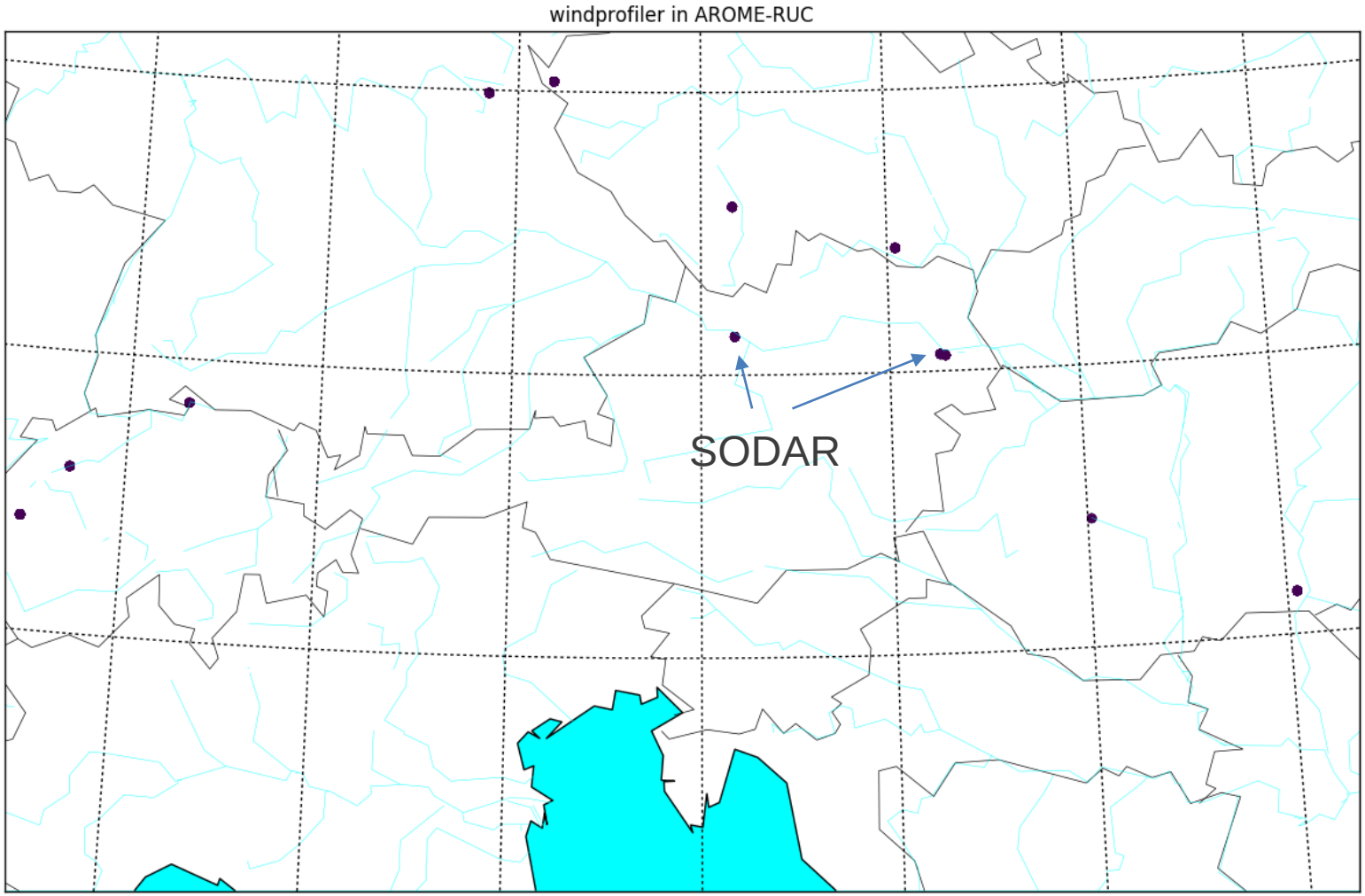
Assimilation of wind profilers / SODAR



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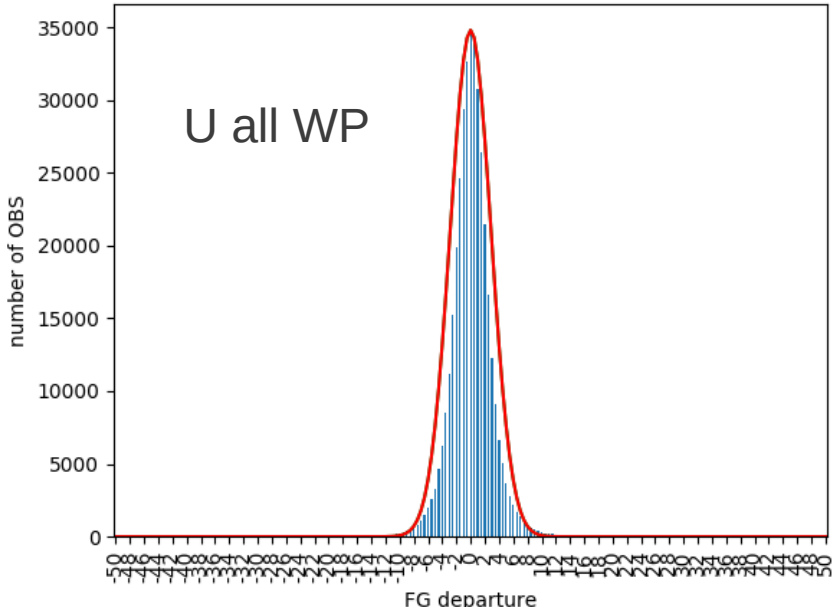
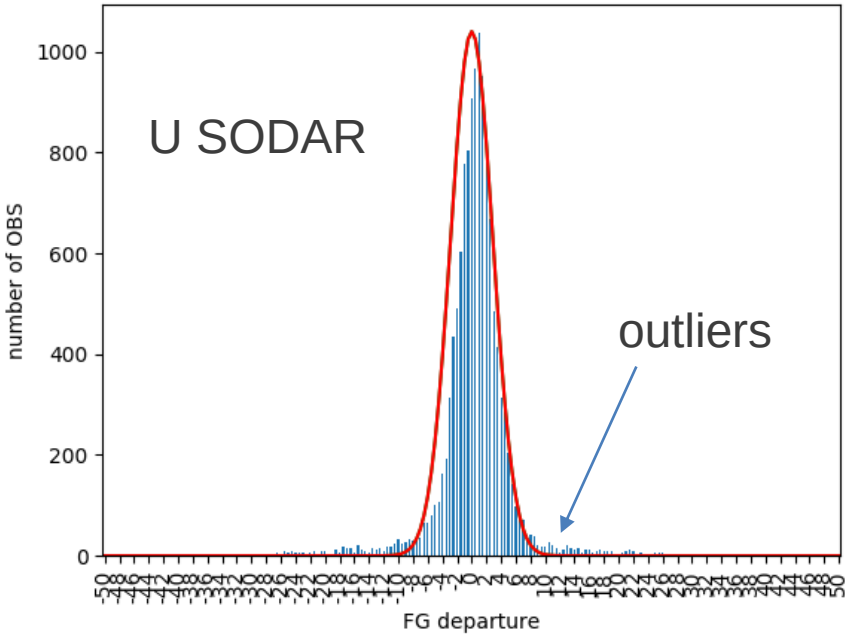
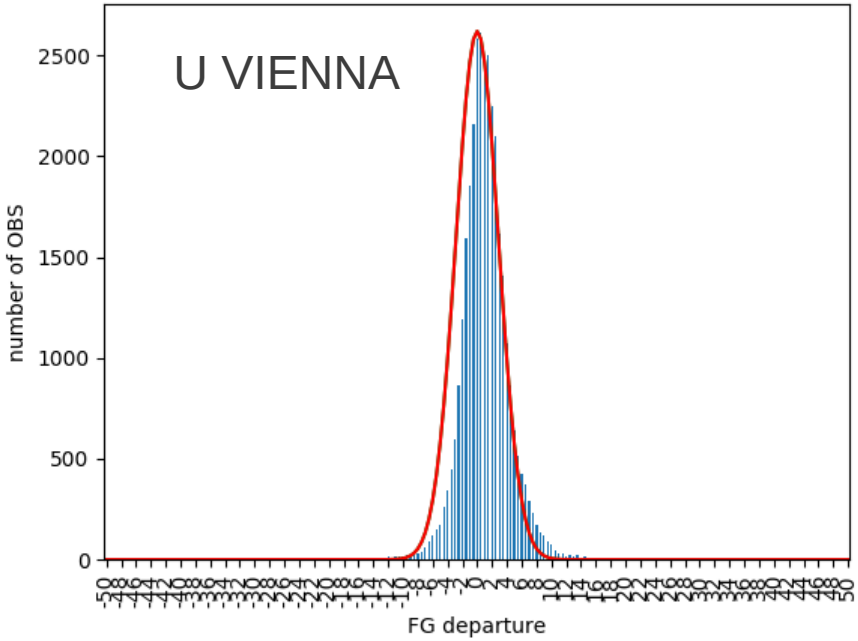
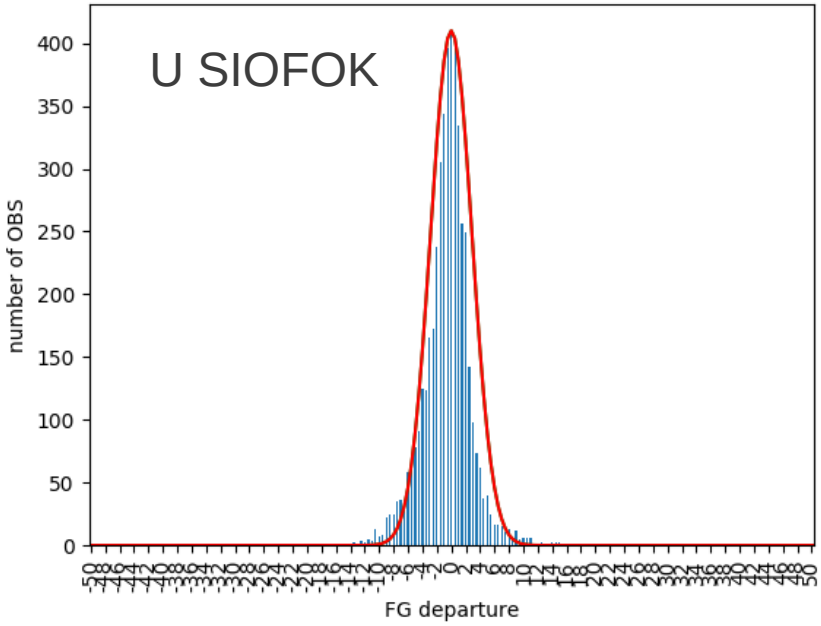


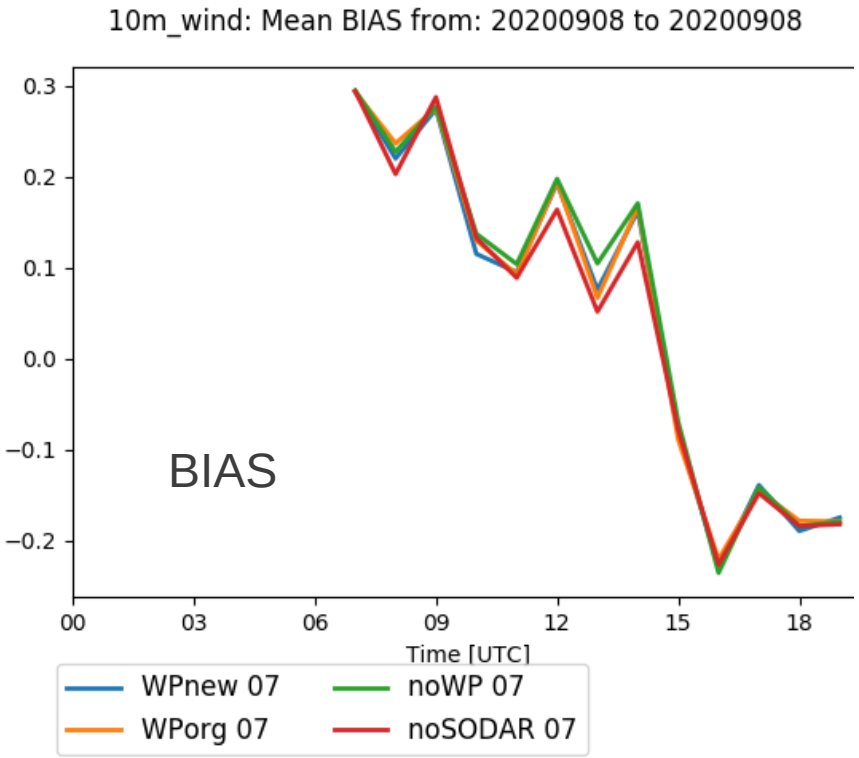


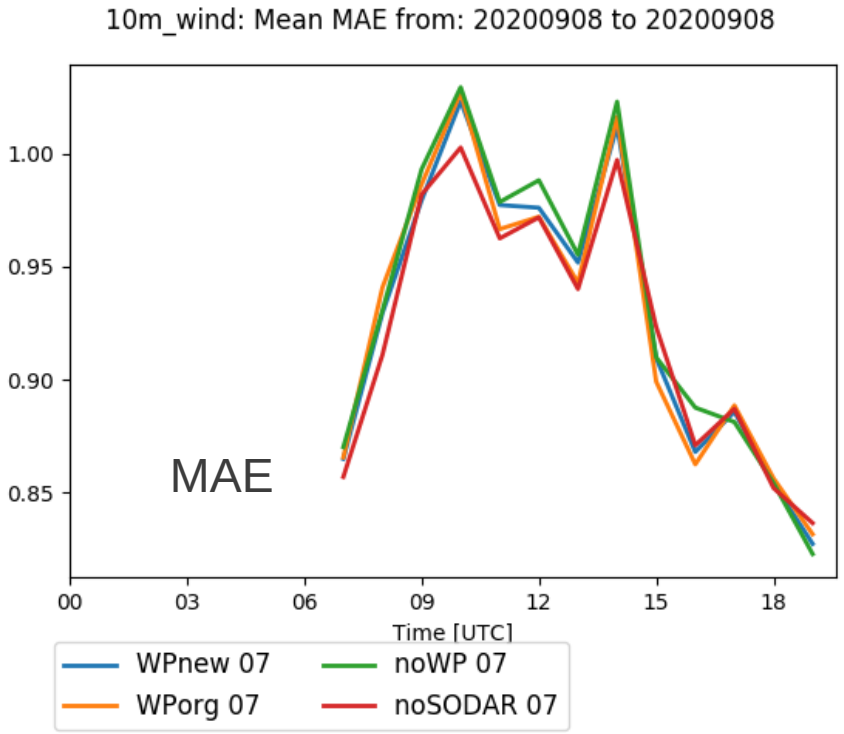
FG-departures 20200819-20200831





Assimilation of wind profilers / SODAR case study





- Yellow WP+SODAR with height attribution from standard atmosphere
- Blue as yellow, but height attribution from First Guess
- Red as blue, but without SODAR only WP assimilated
- Green: reference without WP and SODAR

-> in principle nice impact, but SODAR needs better quality checks

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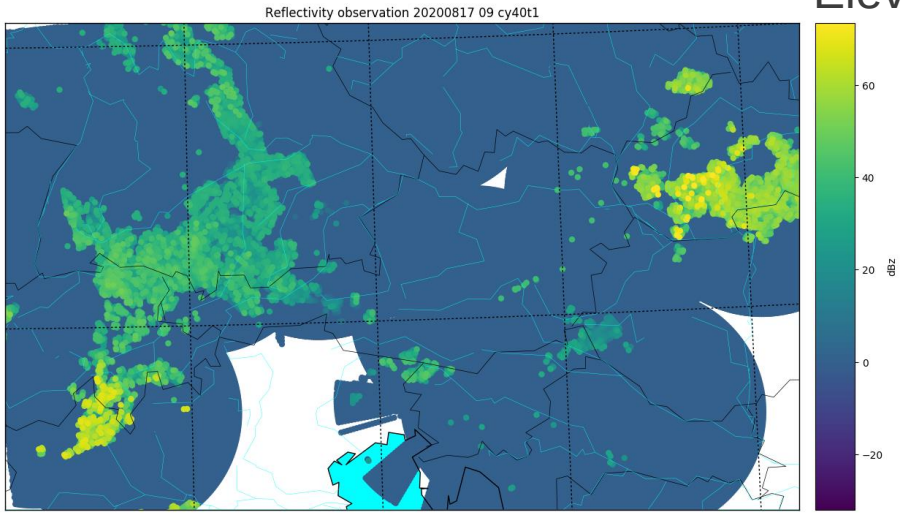
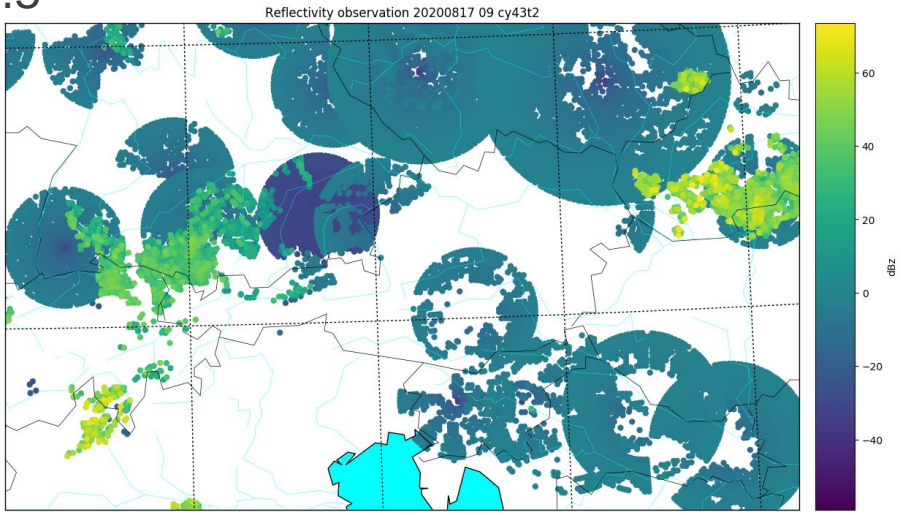
Reflectivity in BATOR cy40t1 (HIRLAM modified) vs cy43t2 MF

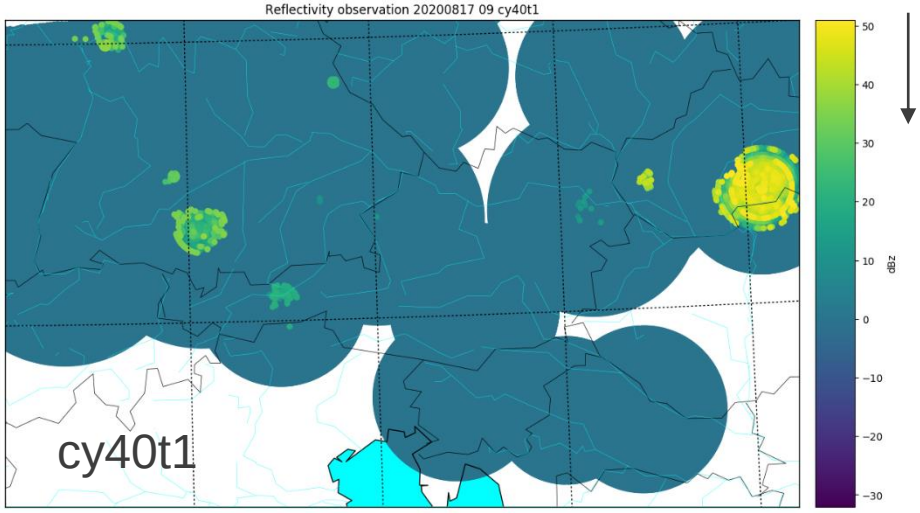
Elev=0.5

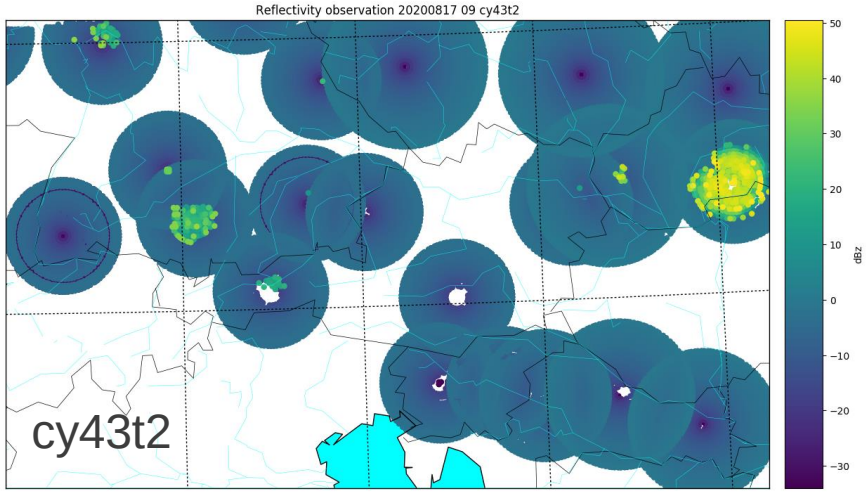




cy40t1 17th August 09UTC cy43t2

Elev=33.0





Reflectivity in BATOR cy40t1 (HIRLAM modified) vs cy43t2 MF

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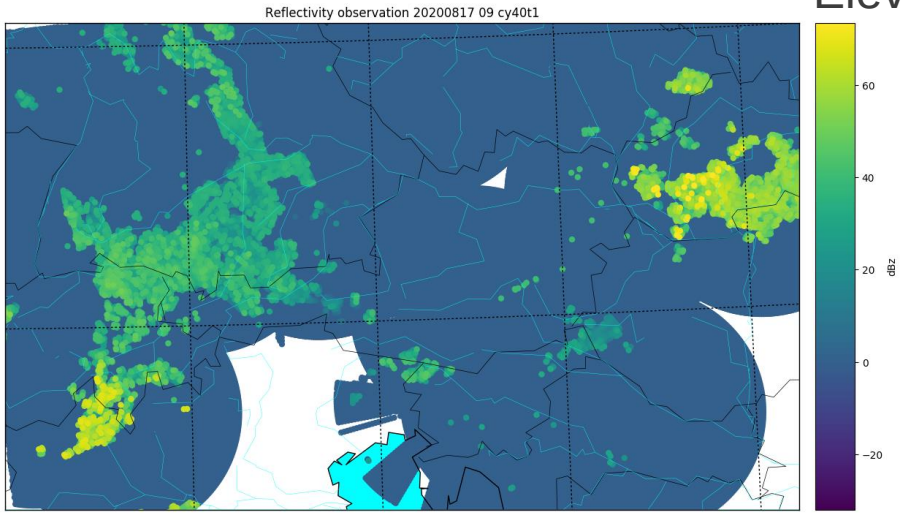
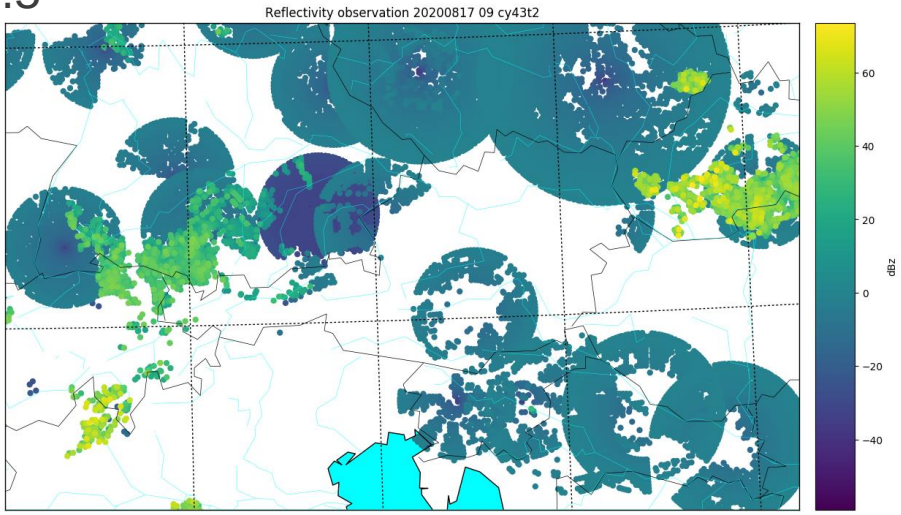
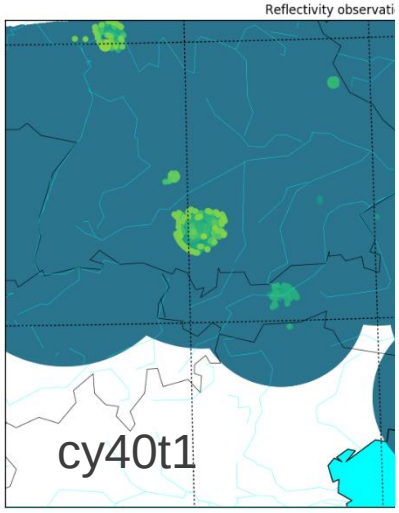
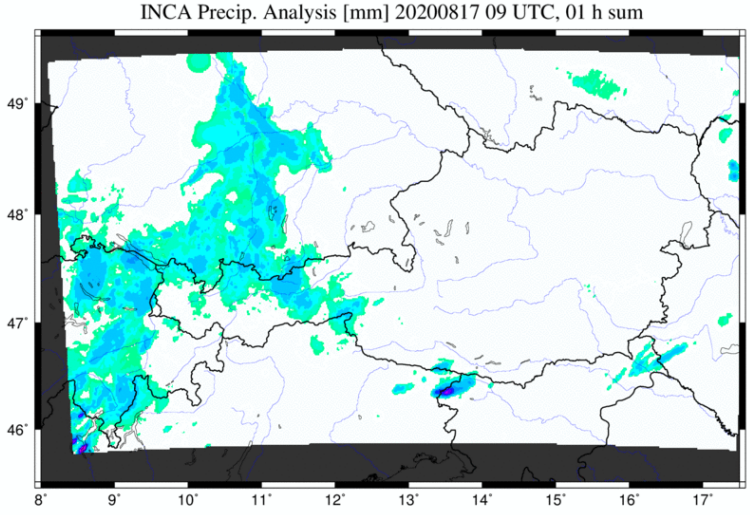
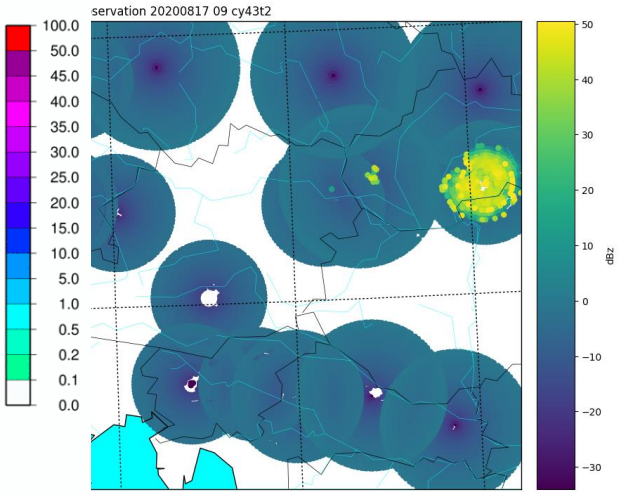




cy40t1 17th







Doppler wind in BATOR cy40t1 (HIRLAM modified) vs cy43t2 MF

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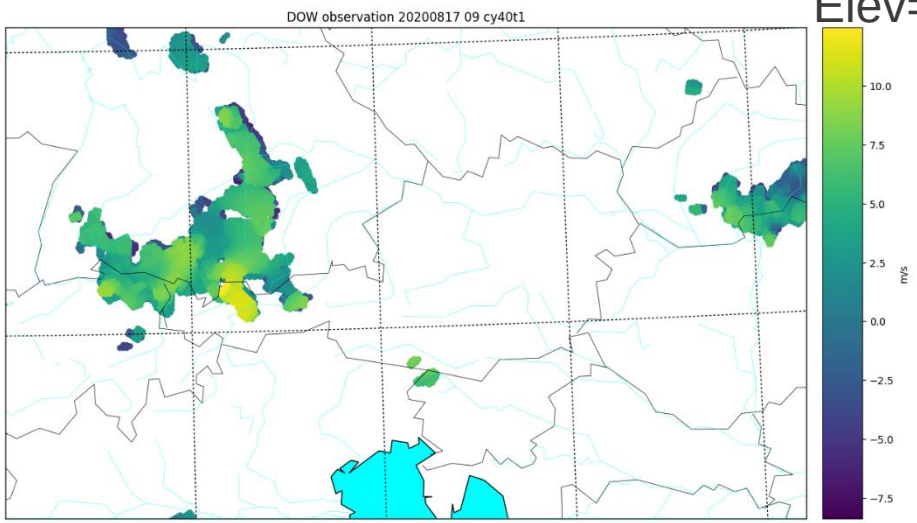
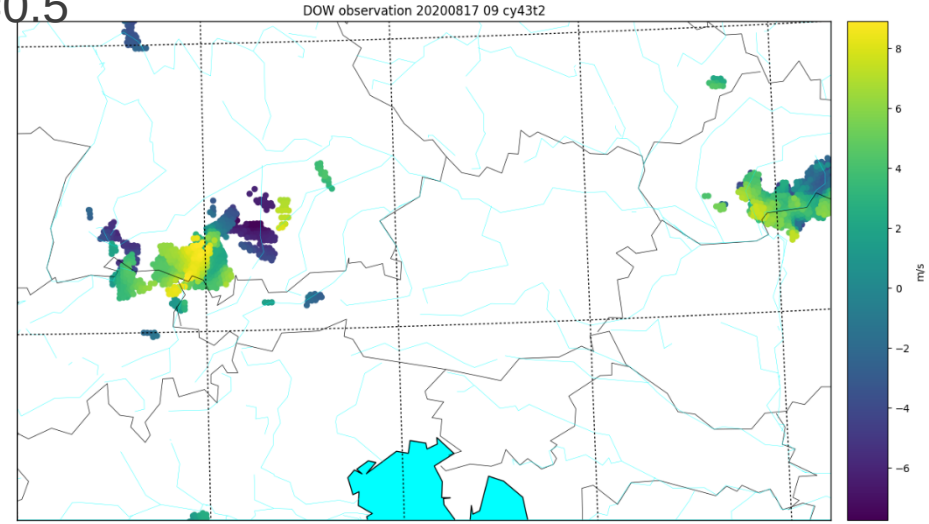


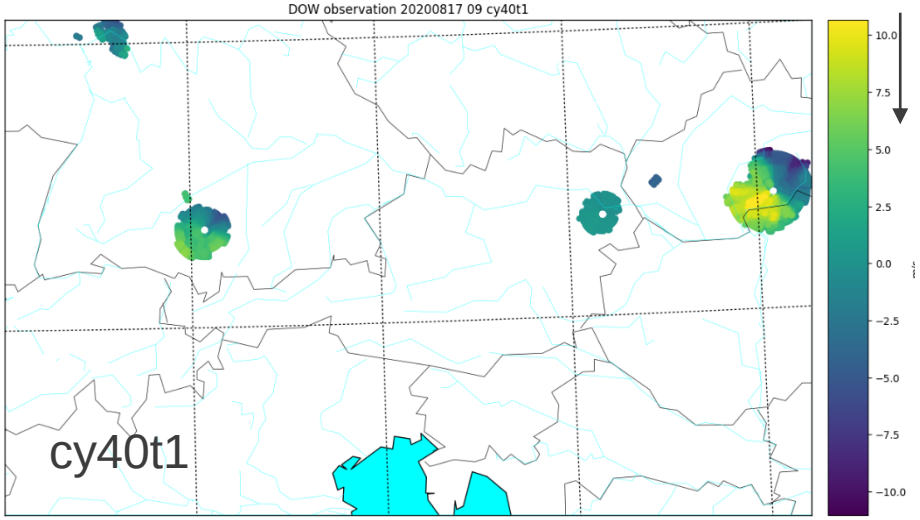


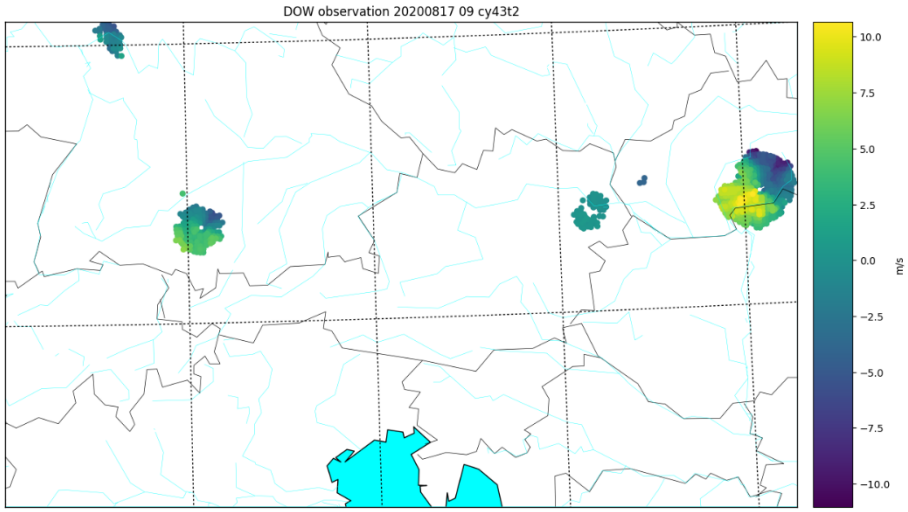
cy40t1

17th August 09UTC

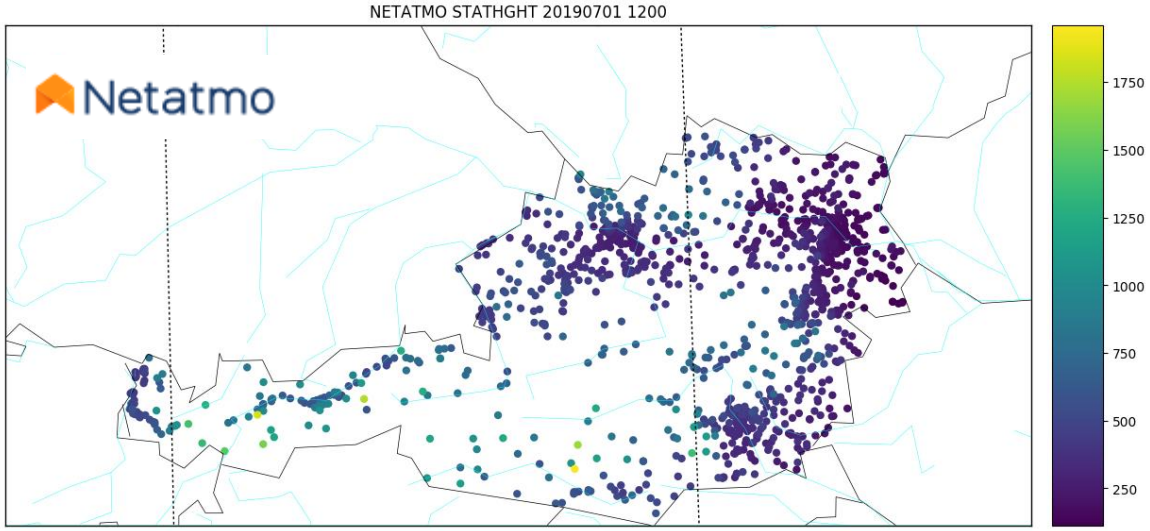
cy43t2

Elev=22.0

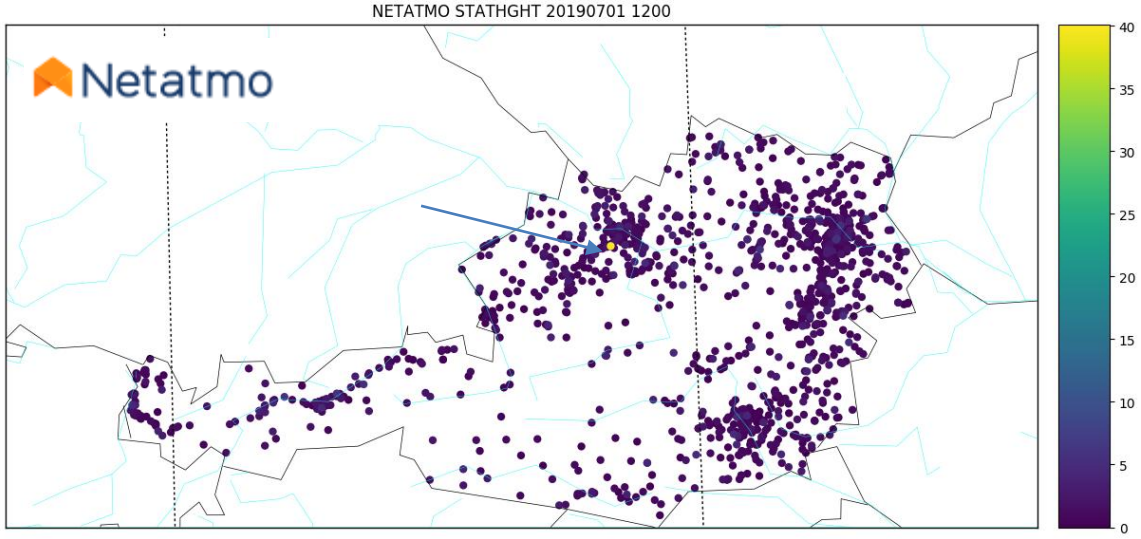




Private weather stations about 8000 stations



Stationheight



10m wind

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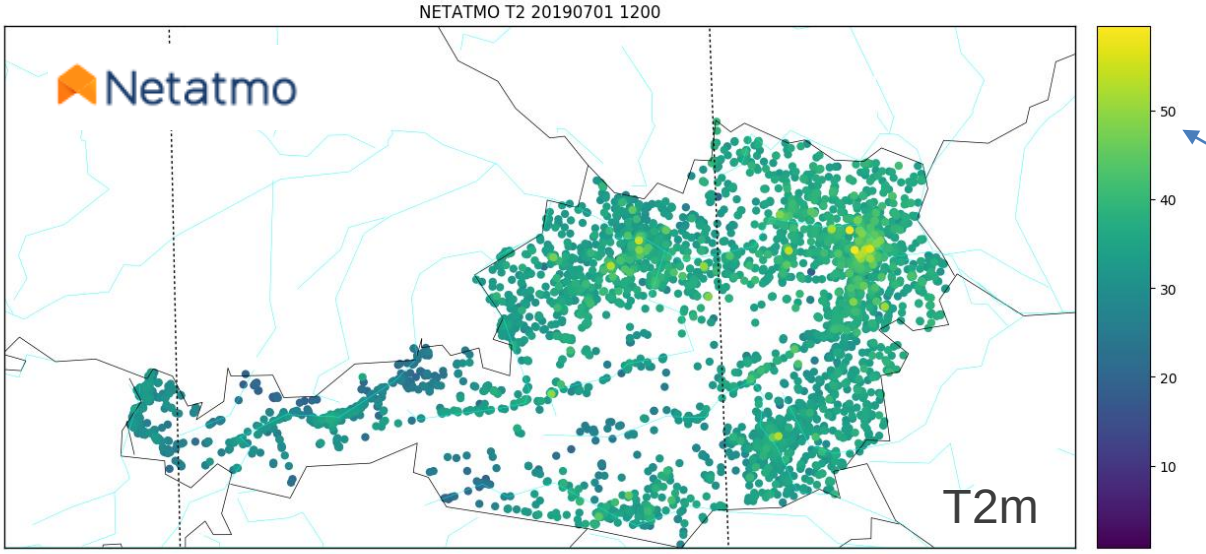
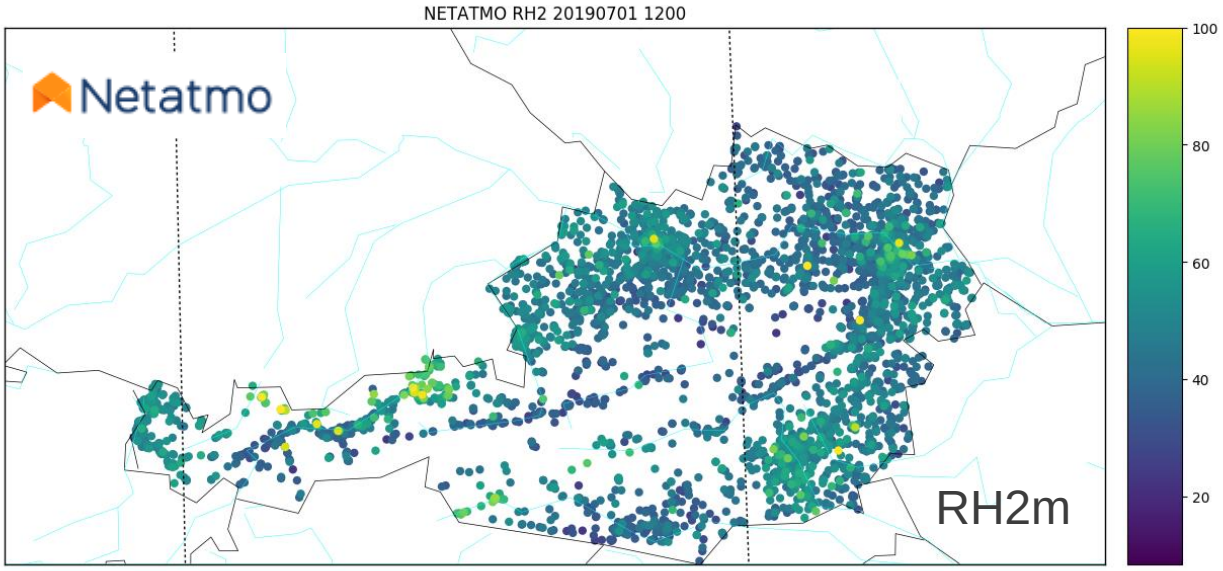
Private weather stations about 8000 stations



QC is crucial



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Further plans

- Assimilation tests with private weather stations
- Poor man‘s ensemble
- Optimise quality control
- GNSS on trains
- Switch to cy43t2 -> include more radar stations
- Test of lead time /domain size extension
- Initialisation of Hydrometeors

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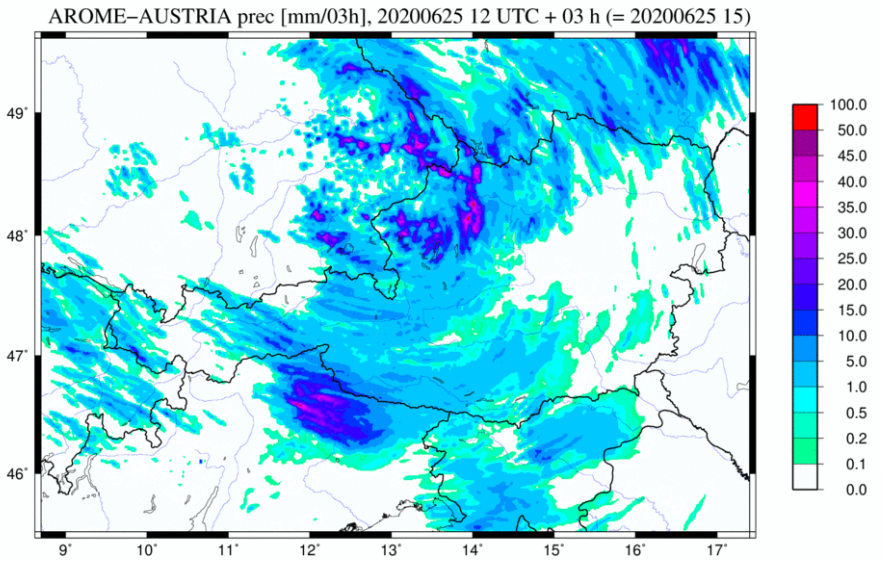
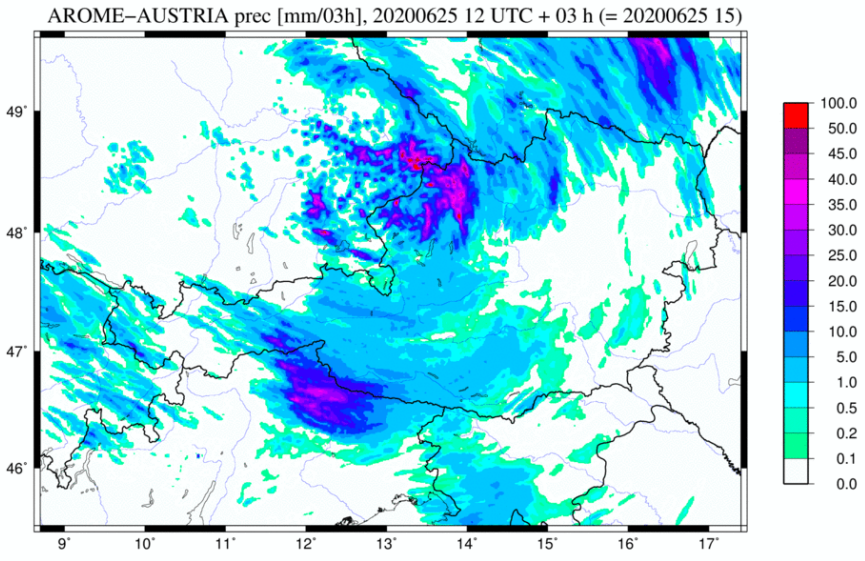
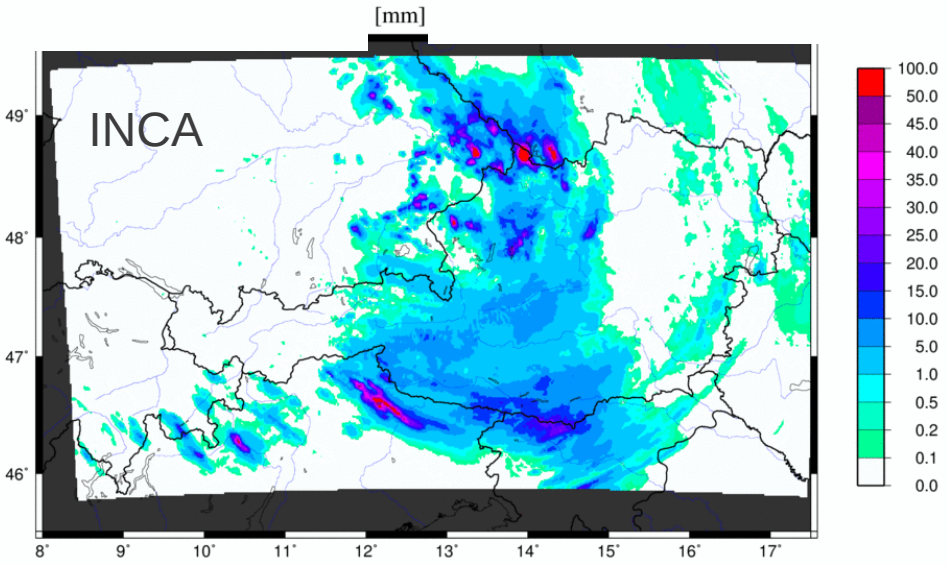
Case study effect of LHN 25th june 2020 12-15UTC



RUC+LHN



RUC noLHN



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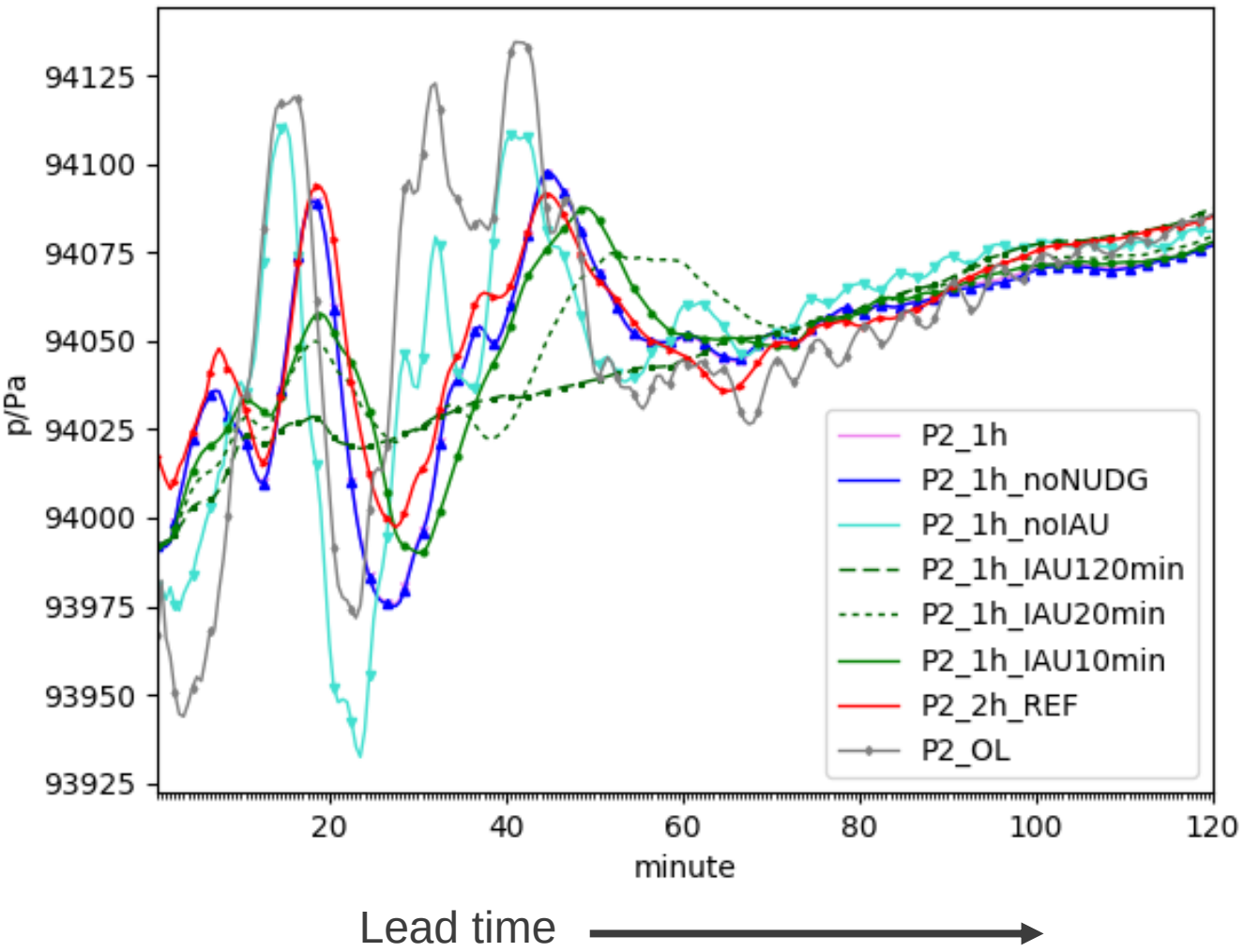
Spin-up and cycling startegy

ECHKEVO spin-up diagnostics



Lead time

- Spin-up >1h
- 2 hourly slightly better than 1 hourly
- Nudging/LHN has no significant impact here
- IAU filtering works
- „Open loop“ is especially problematic 2.5km ->1.2km

<u>Reasons:</u>

B-Matrix not well defined?
Complex orography
and domain not optimal?

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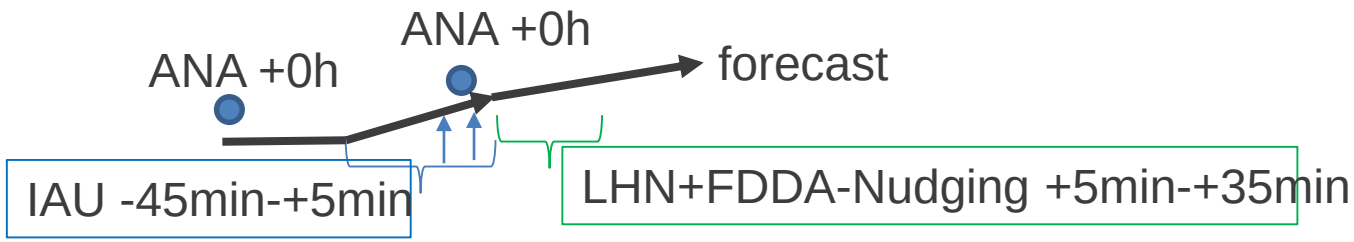
Hourly or 2 hourly cycling?

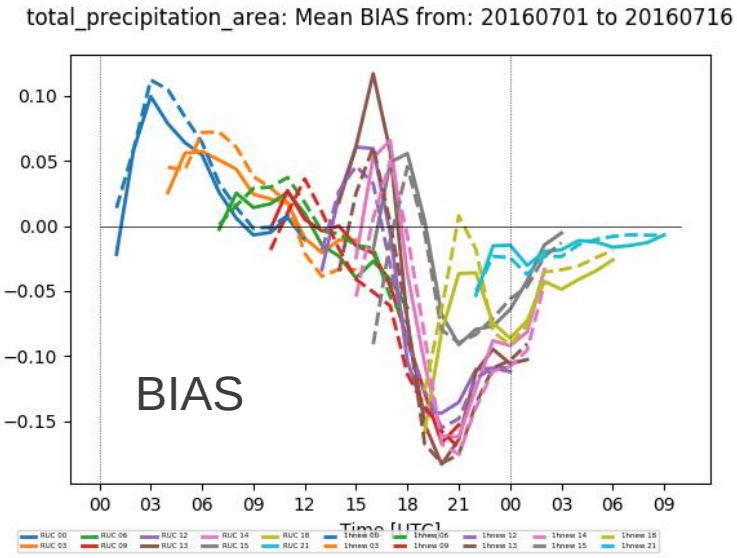
standard hourly cycling performed extremly bad compared to two hourly (Bias+RMSE)

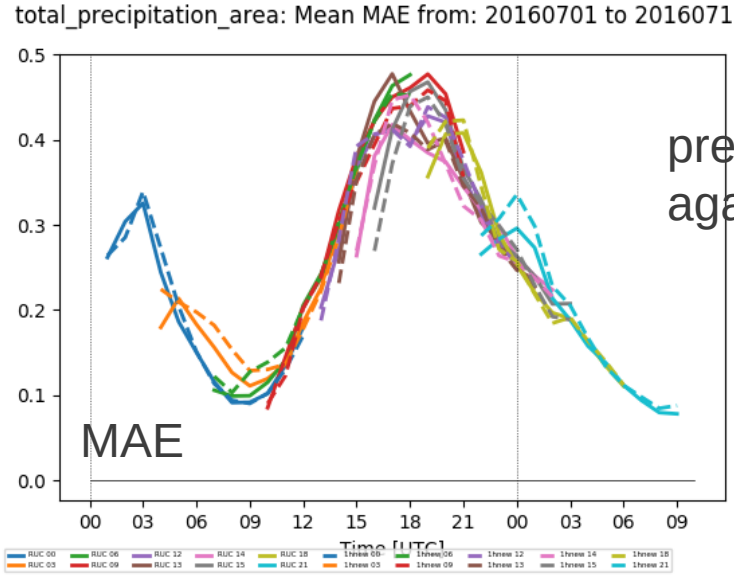
Idea:

Start one hour in advance and push forecast towards analysis to reduce spin-up time

avoid competition of IAU and Nudging







precip. against INCA

1 Hourly with extended IAU dashed vs 2 hourly solid

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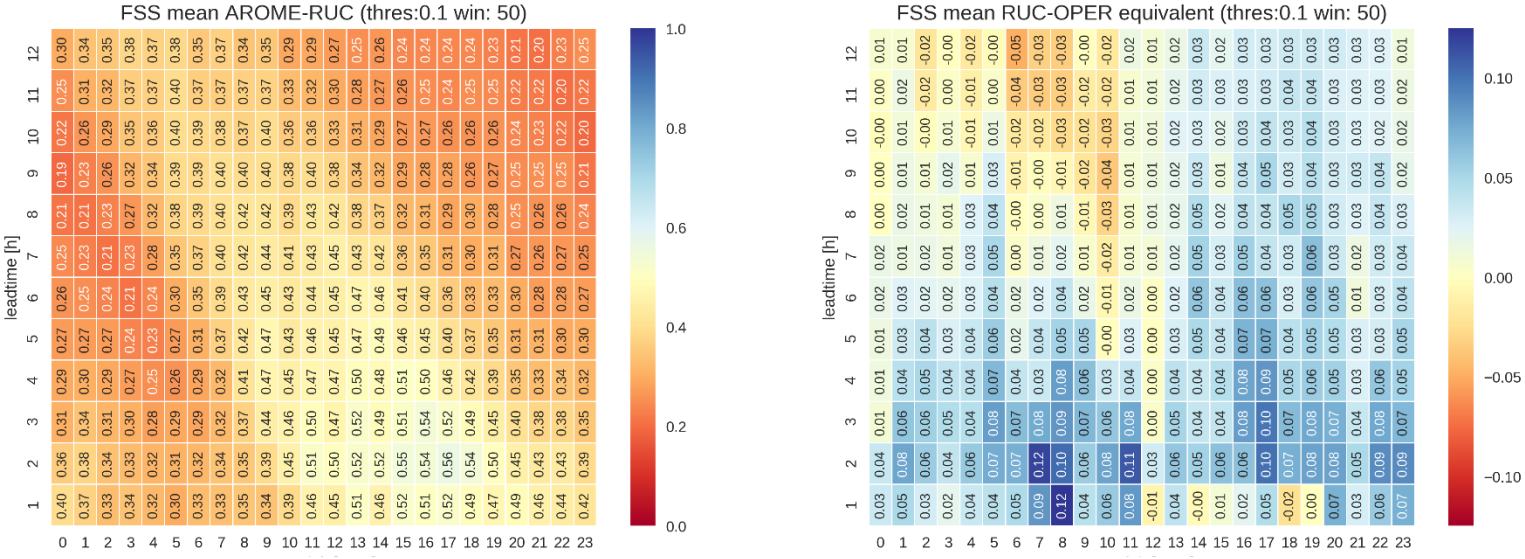
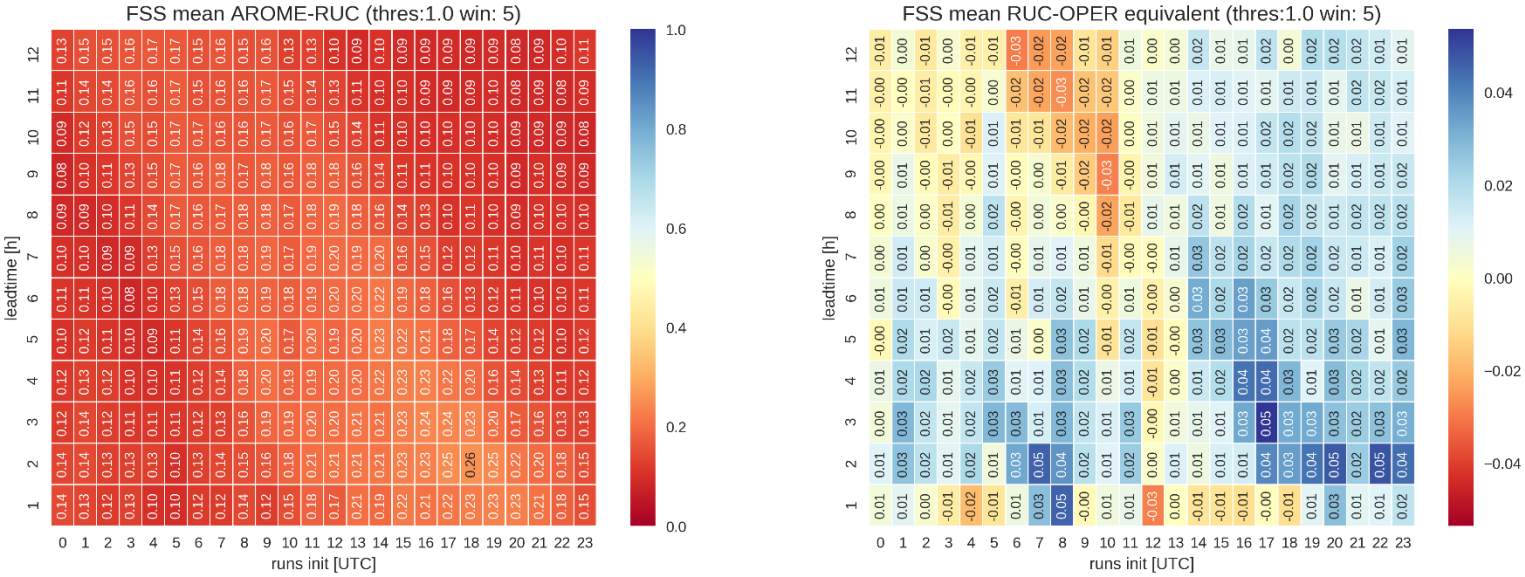
Validation of precipitation summer



Fraction Skill Score FSS July 2016

difference in FSS to freshest AROME 2.5km

Lead time



INIT TIMES (24 runs)

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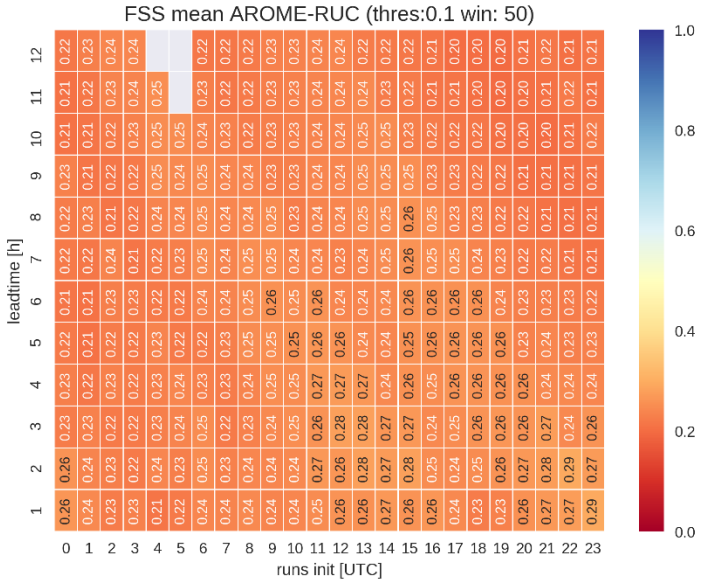
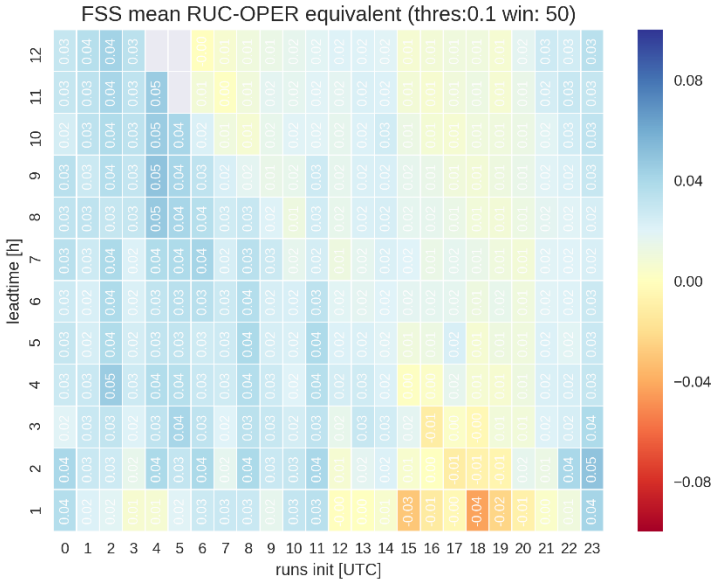
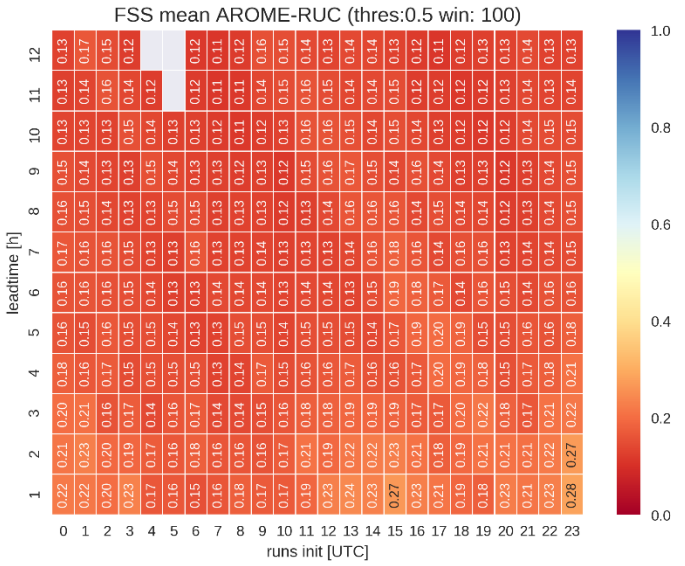
Validation of precipitation winter

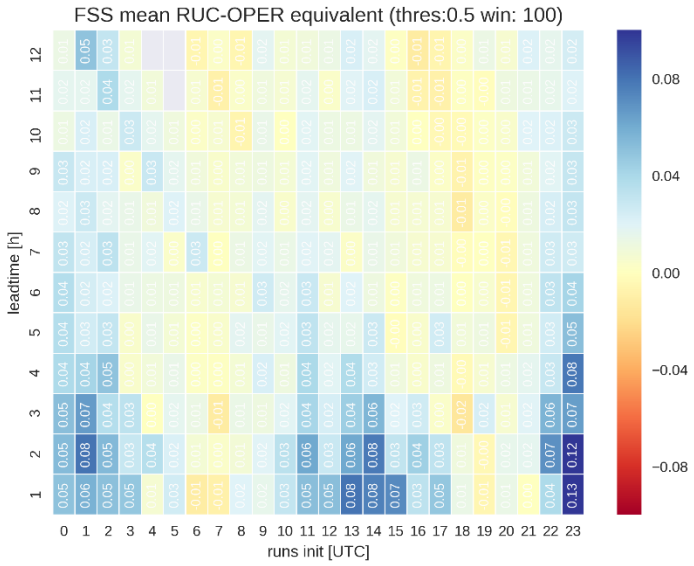




Fraction Skill Score FSS January 2017 difference in FSS to freshest AROME 2.5km

Lead time





INIT TIMES (24 runs)

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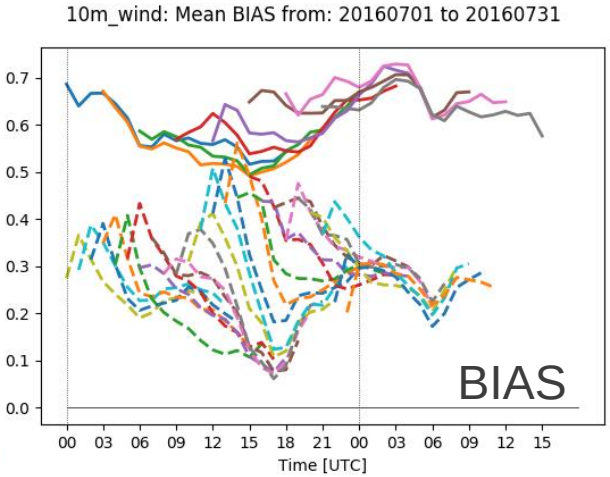
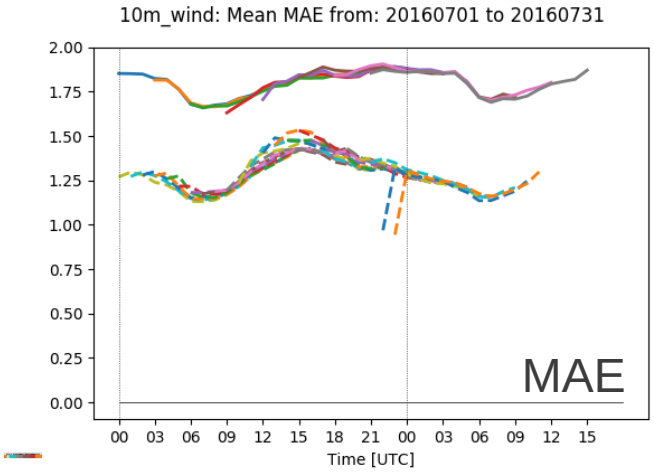
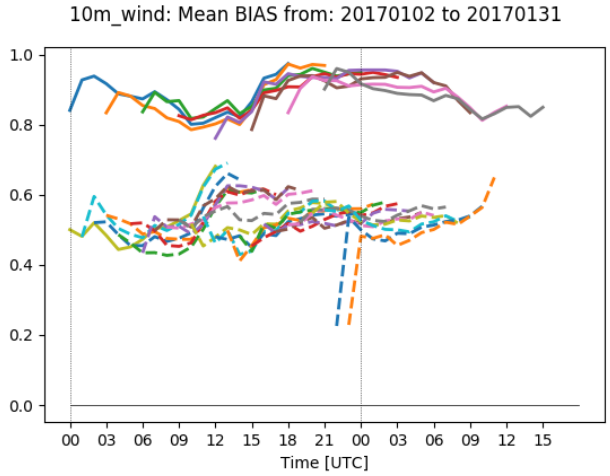
Validation July 2016, January 2017 wind



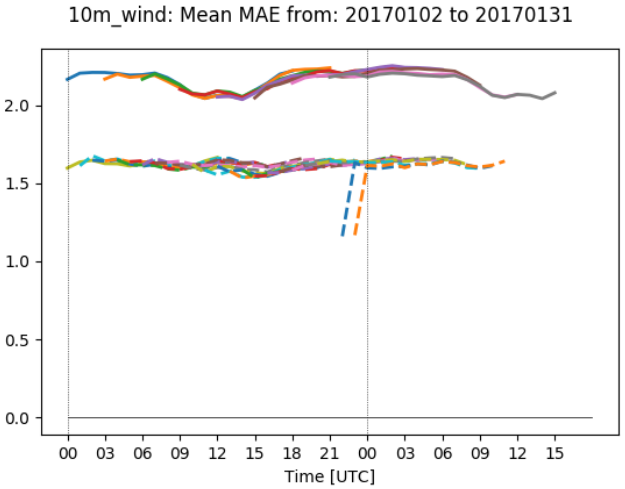
July



AROME 2.5km soild; AROME-RUC dashed



January



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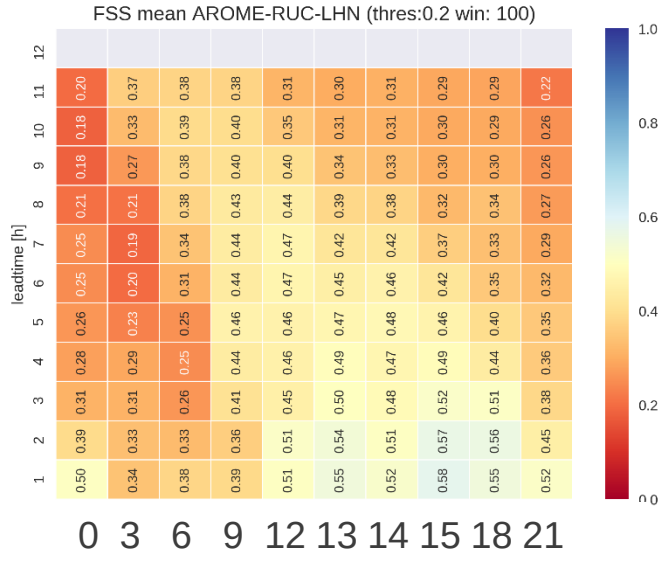
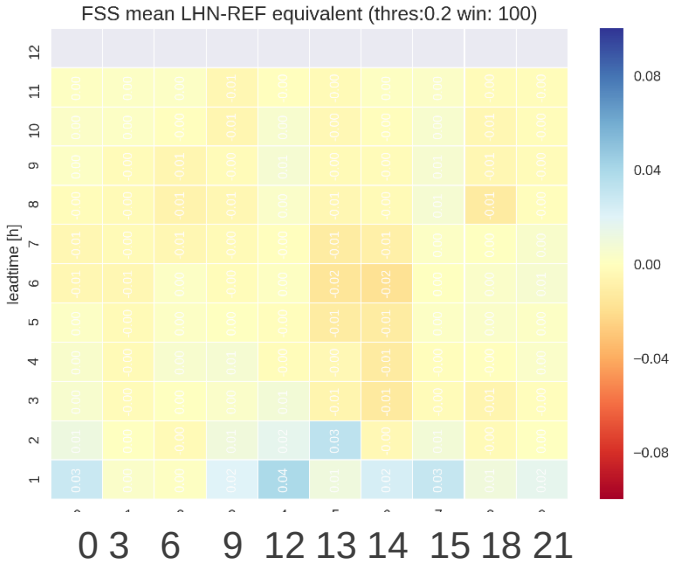
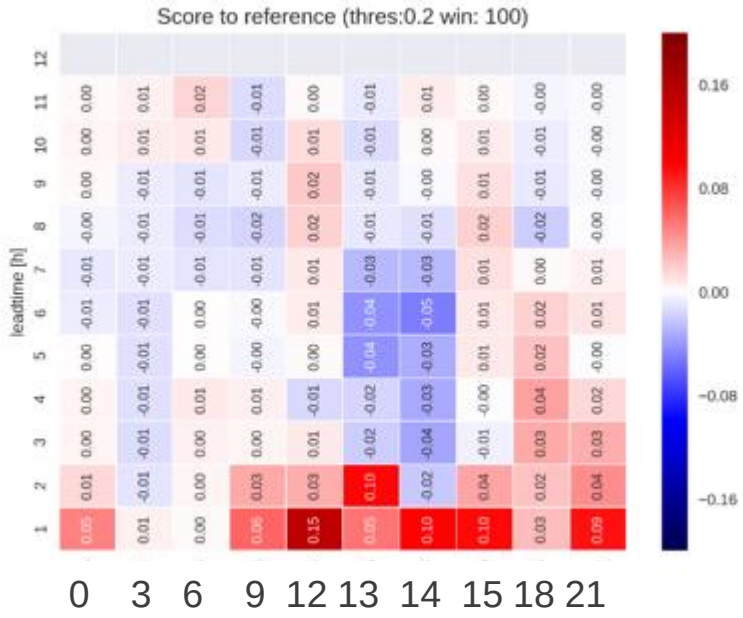




Validation of Latent Heat Nudging 1st-16th July 2016



- slight improvement up to +2h
- expectation from literature about +6h
- poor statistics (16 days) and small domain
- further tuning necessary

$$\sum \frac{FSS_{exp} - FSS_{ref}}{1 - Fss_{ref}} \quad if\ Fss_{exp} > Fss_{ref}$$

$$+ \sum \frac{FSS_{exp} - FSS_{ref}}{1 - Fss_{exp}} \quad \text{else}$$

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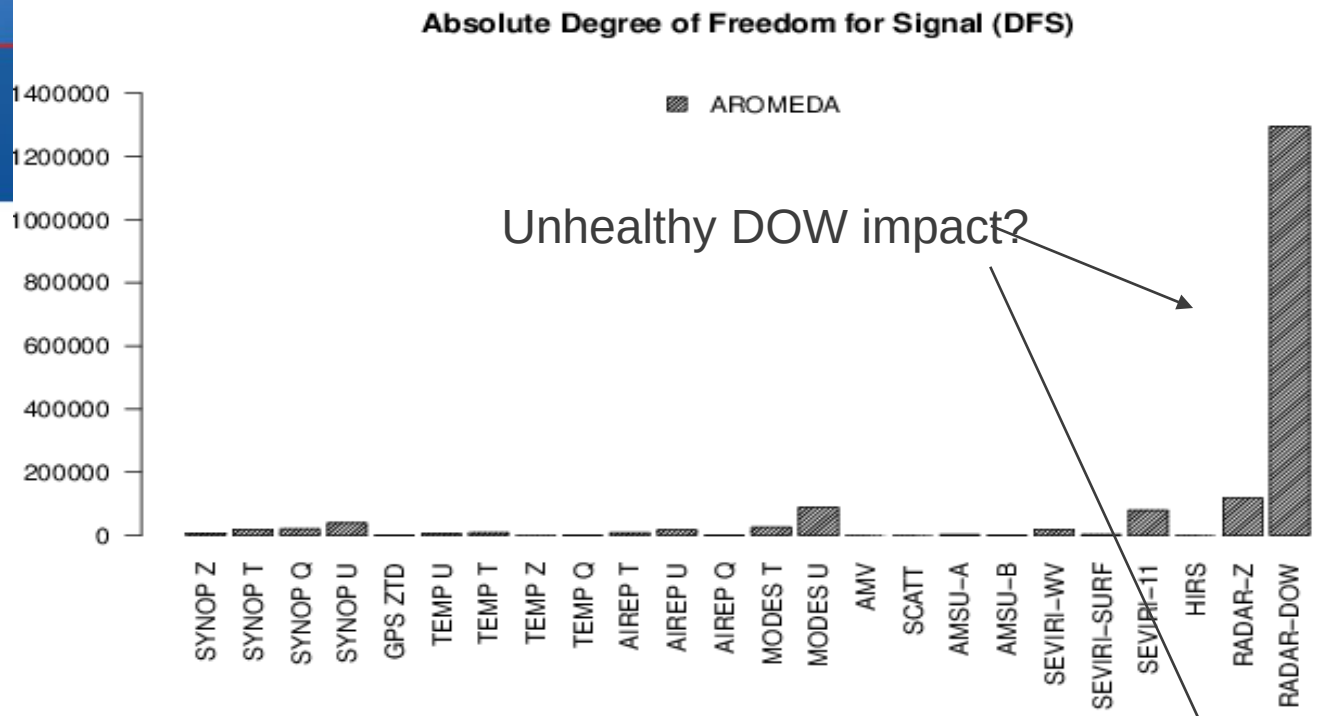
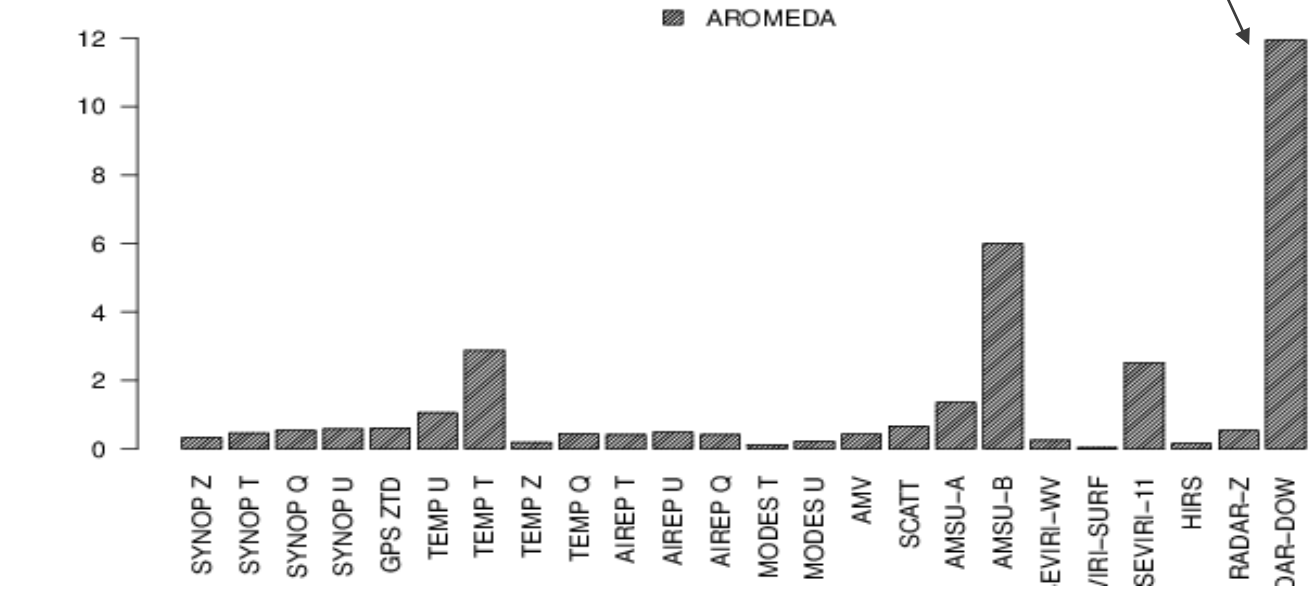


Unhealthy DOW impact?



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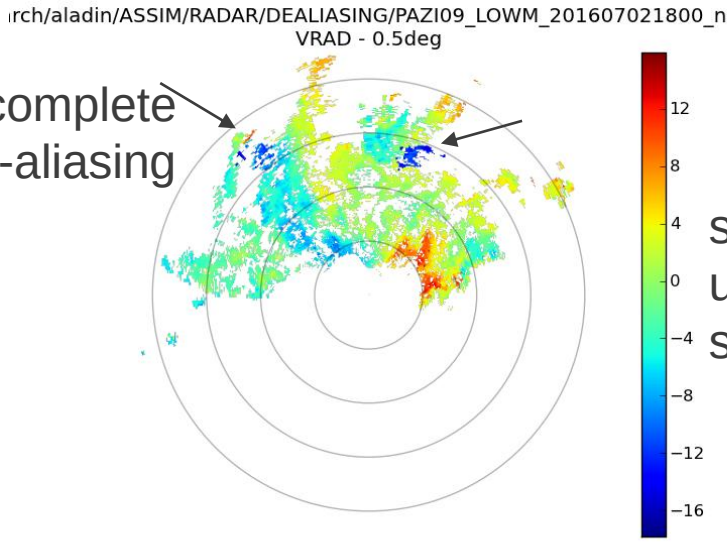
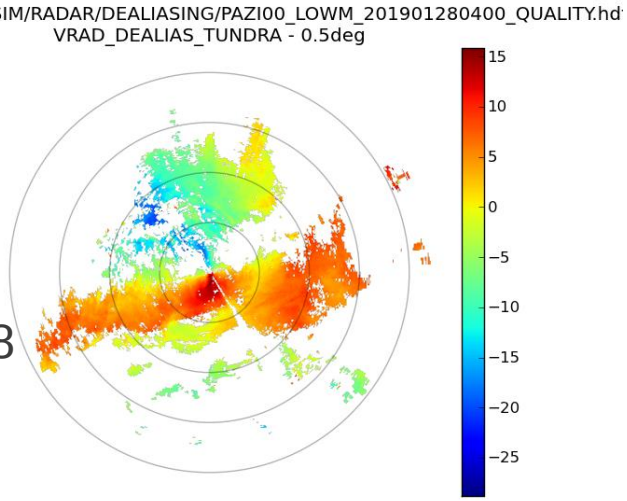
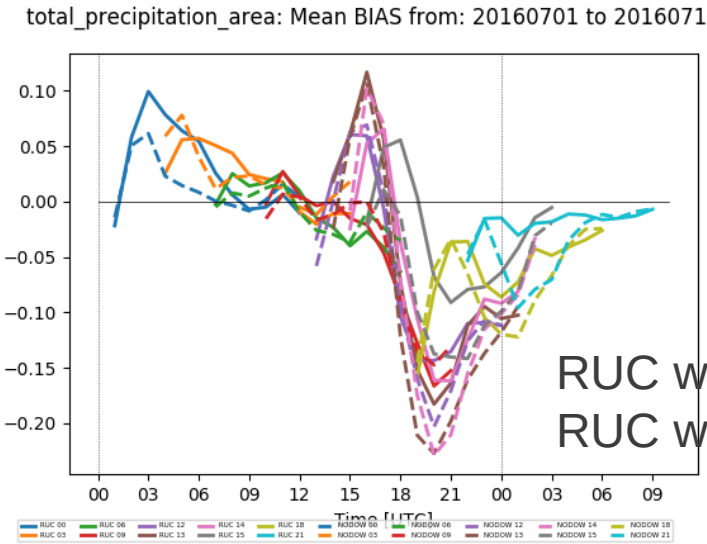
Radar DOW assimilation still problematic



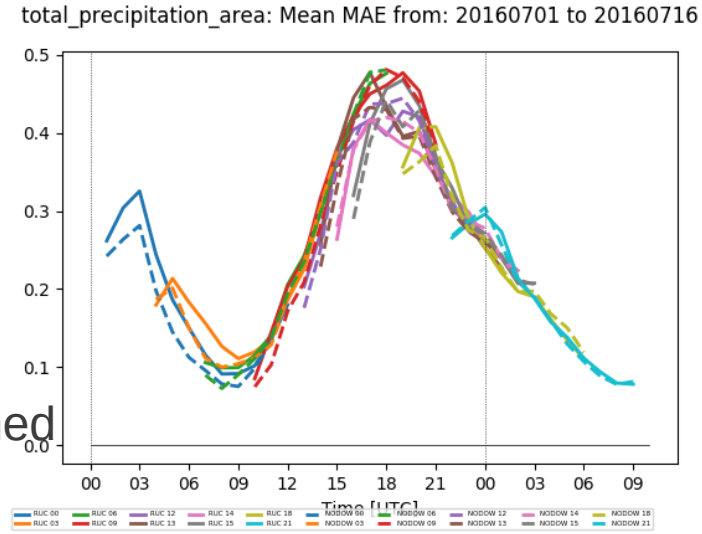
incomplete de-aliasing

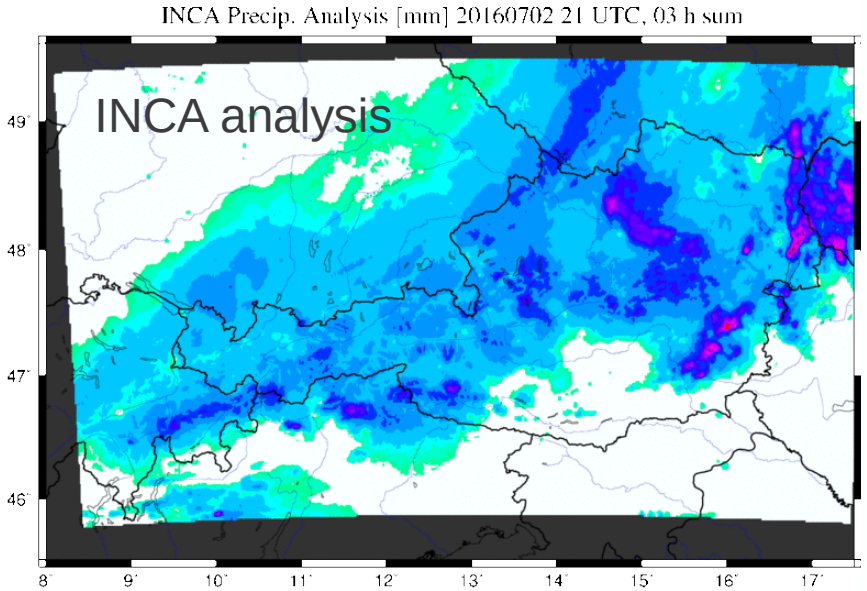
signal processor upgrade in Austria summer/autumn 2018



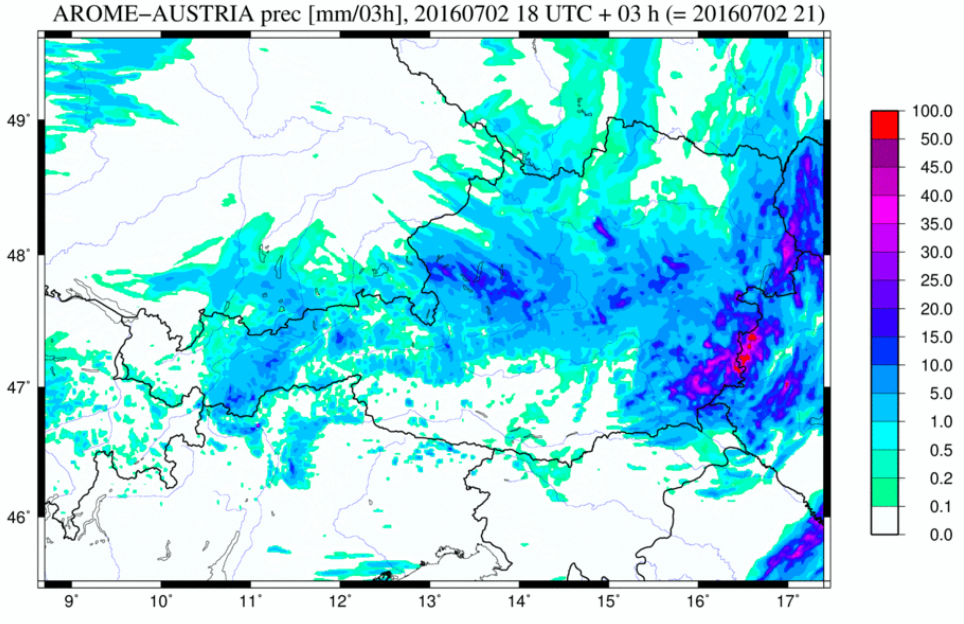


RUC with Doppler solid
RUC without Doppler dashed

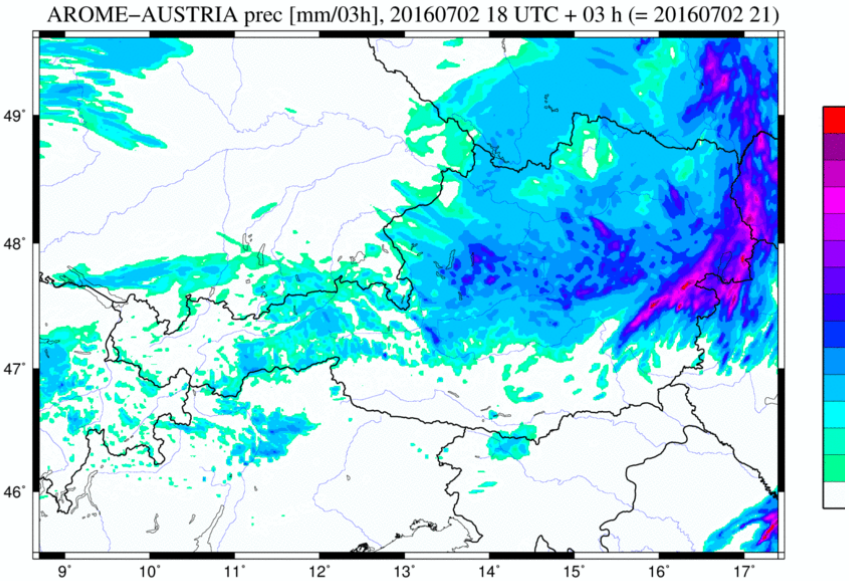




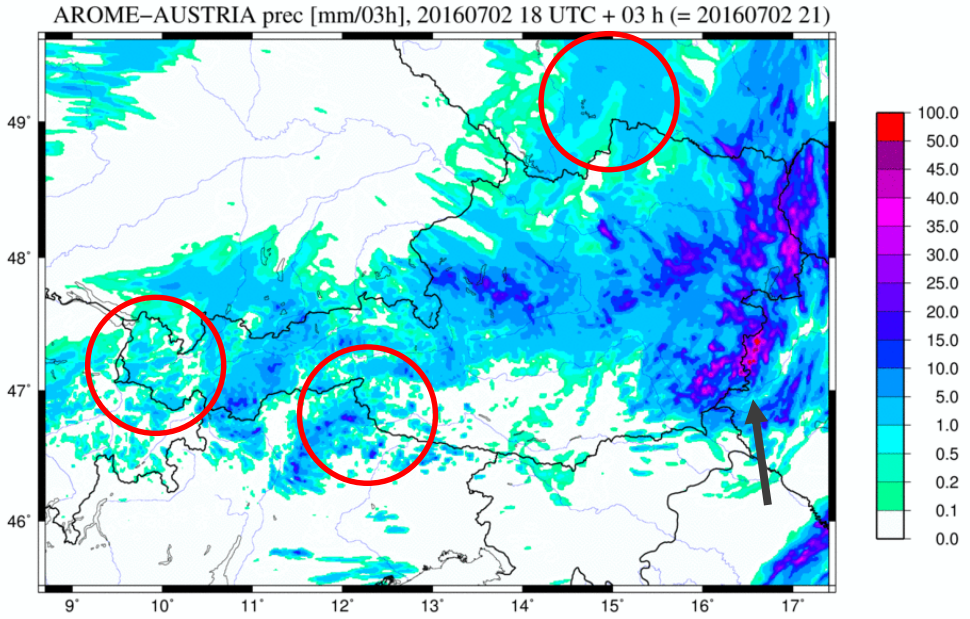
2nd July 2016 RR 18UTC +3h



AROME-RUC with radar DOW+REF

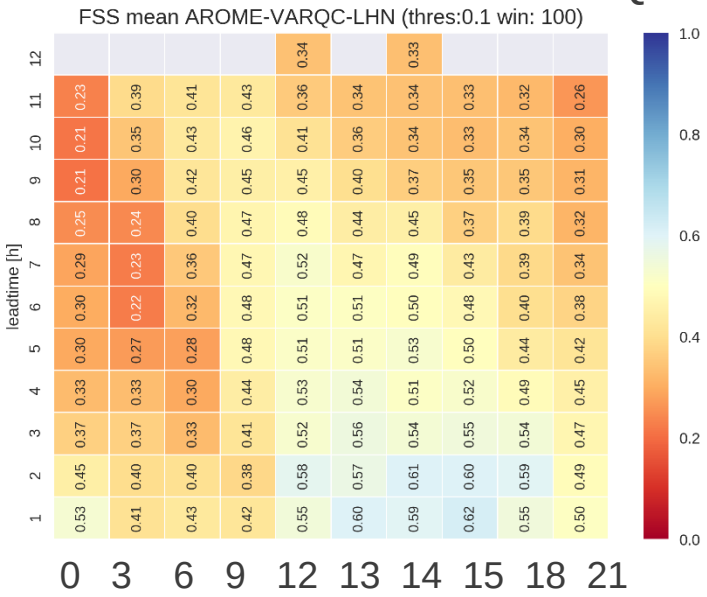


AROME-RUC without Doppler wind assim

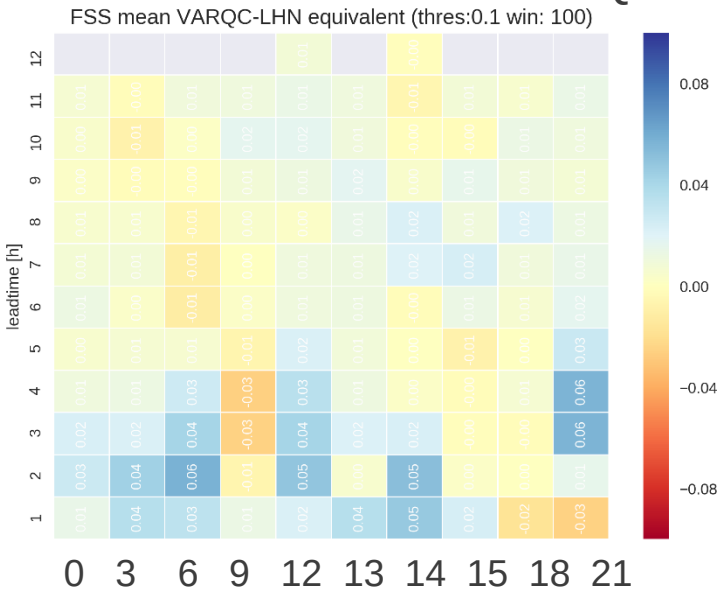


AROME-RUC+DOW+VARQC

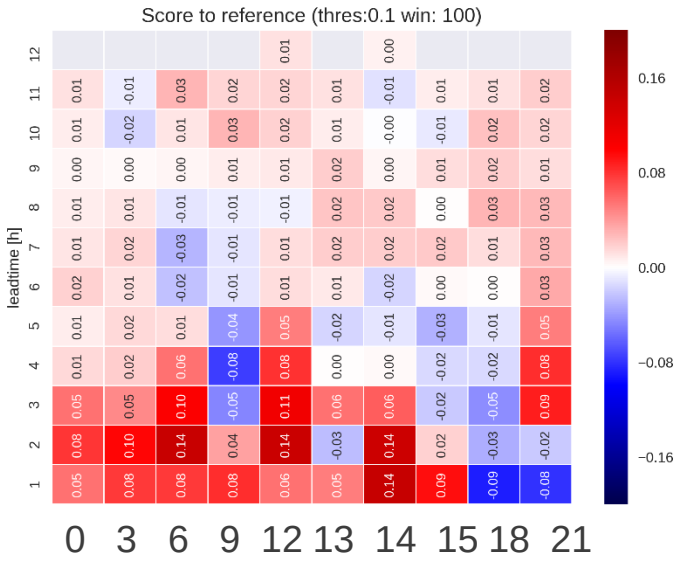
FSS AROME-RUC+VARQC



FSS AROME-RUC+VARQC-noVARQC



1st-16th July 2016



- even the not tuned VARQC can improve the precip. forecast
- difficult to switch on VARQC for only one obstype

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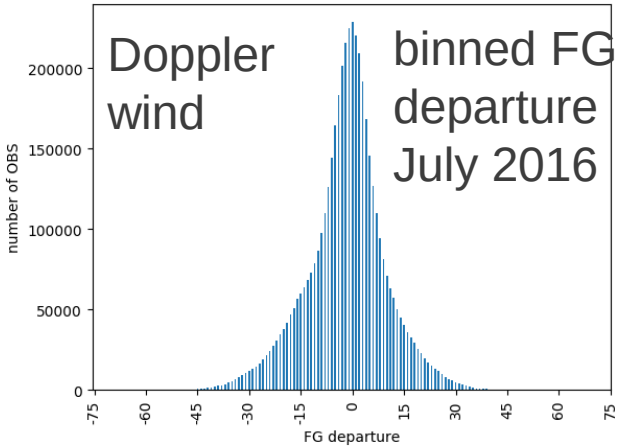
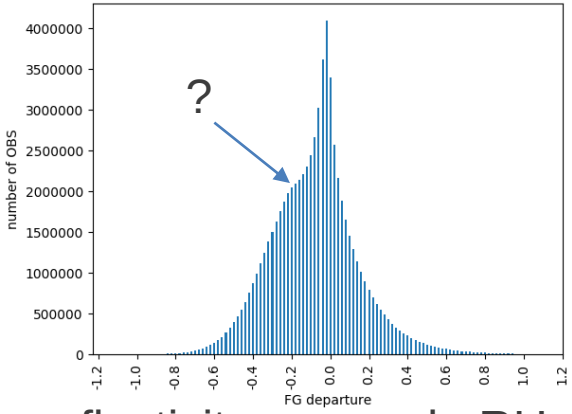
VARQC of radar? (gross errors get reduced weight)

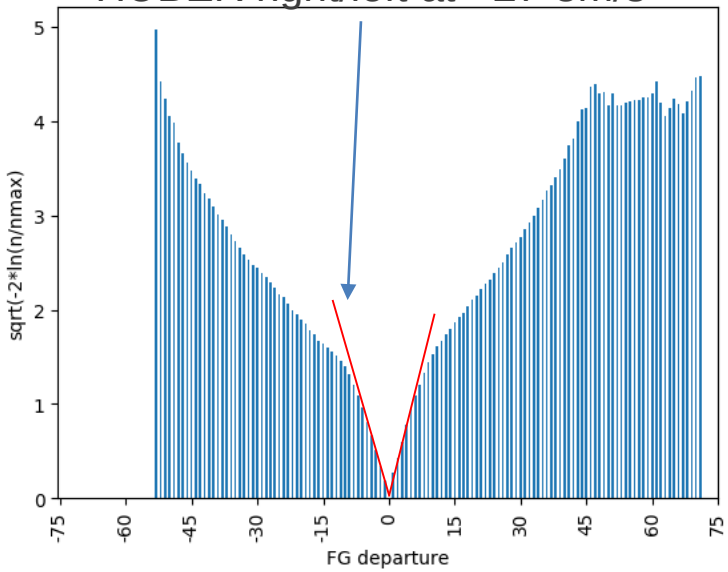
Ingleby &Lorenc 1993



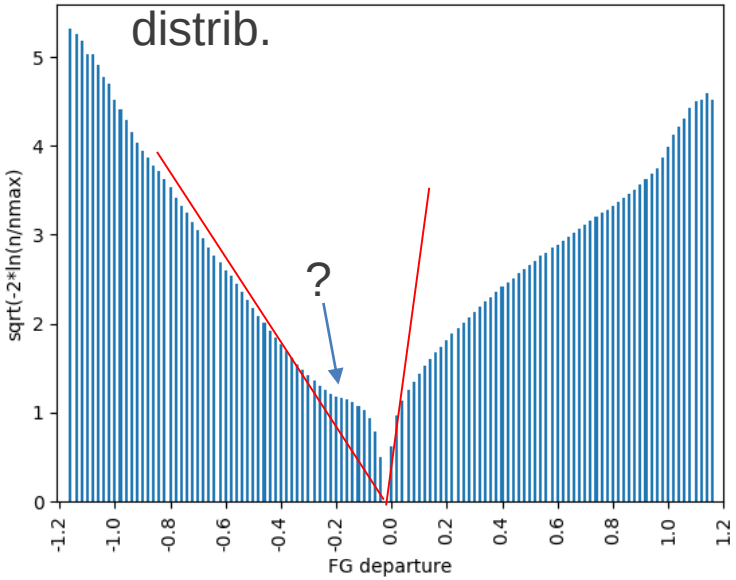
Austrian radars only



switch from gaussian to gross error
HUBER right/left at ~±7-8m/s



reflectivity ->pseudo RH obs
no simple gaussian error distrib.



Conclusions and plans

- AROME-based Nowcasting is feasible
- Improvement in 10m wind (and gusts) (BIAS+MAE) and summer precipitation (FSS until +6h)
- Latent heat nudging improves mostly up to +2h, in single case more
- for us: hourly cycling only possible with long IAU filtering (complex terrain+B-Matrix?)
- Doppler wind has to much impact (aliasing remnants) -> VARQC might help
- Radar assimilation struggles, if no fitting feature is included in the first guess in the surrounding of an observation -> saturation of profile can help, but is dangerous if OBS has error, LHN can also help

- Put AROME-RUC to operations within this year
- Consider post-processing and visualisation
- B-Matrix is currently updated with EDA approach coupled to C-LAEF ->tests
- Quality control, especially for Doppler wind has to be re-considered
- Inclusion of further observations:
  wind profiler, cloud assimilation, private weather stations, HRV AMVs

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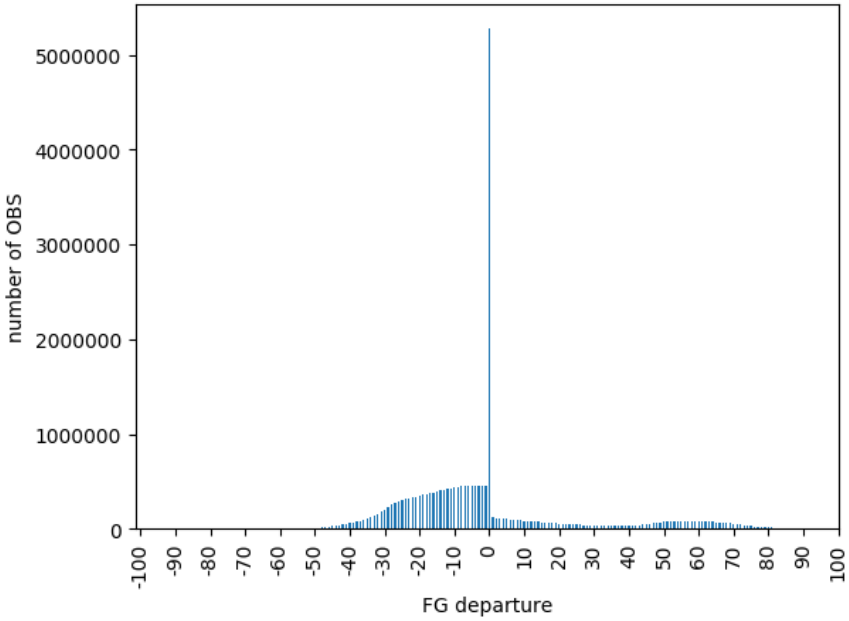

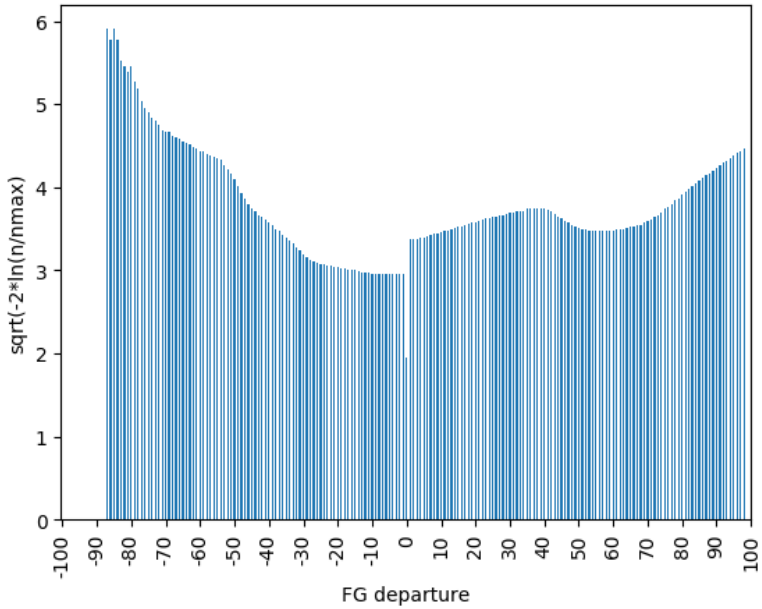

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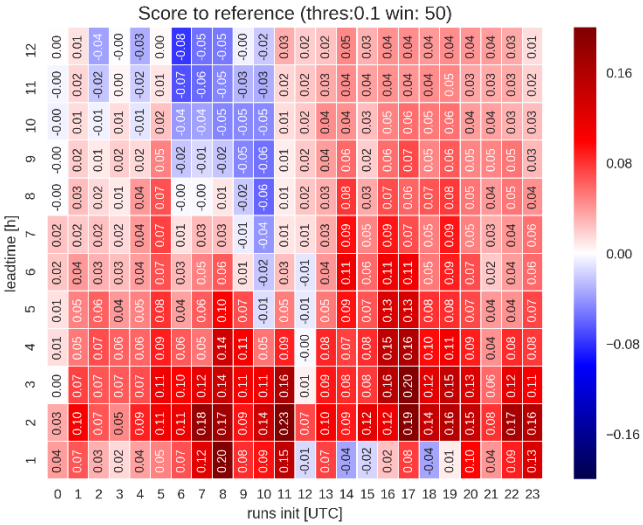

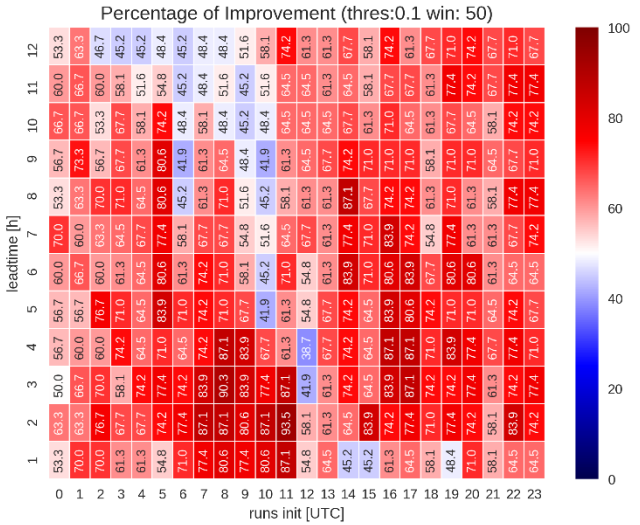

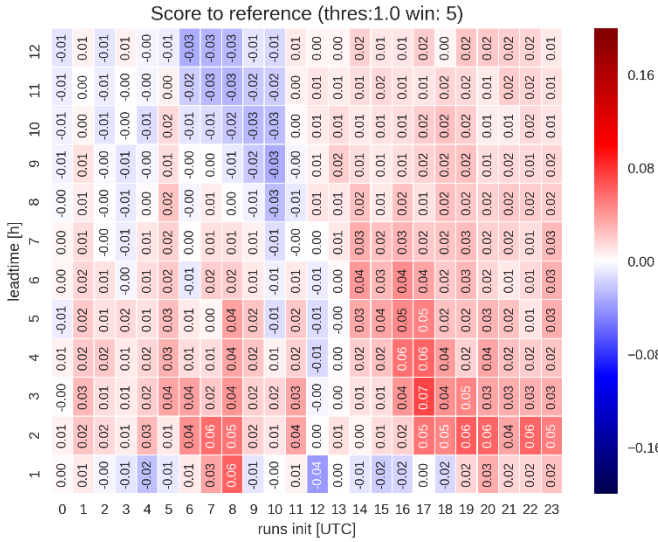

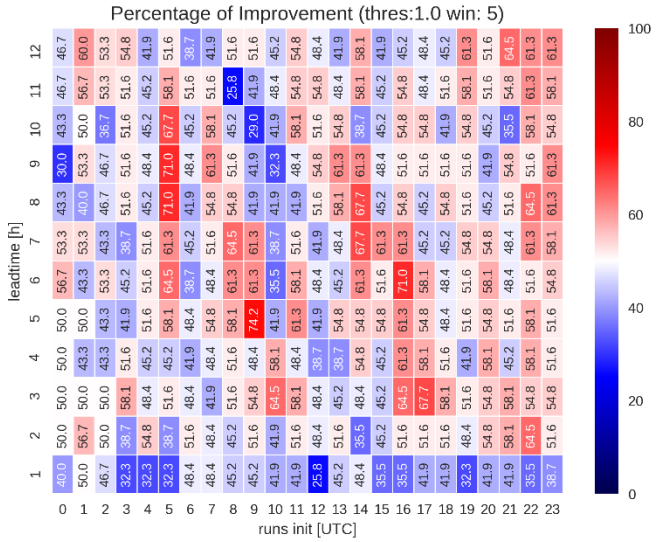

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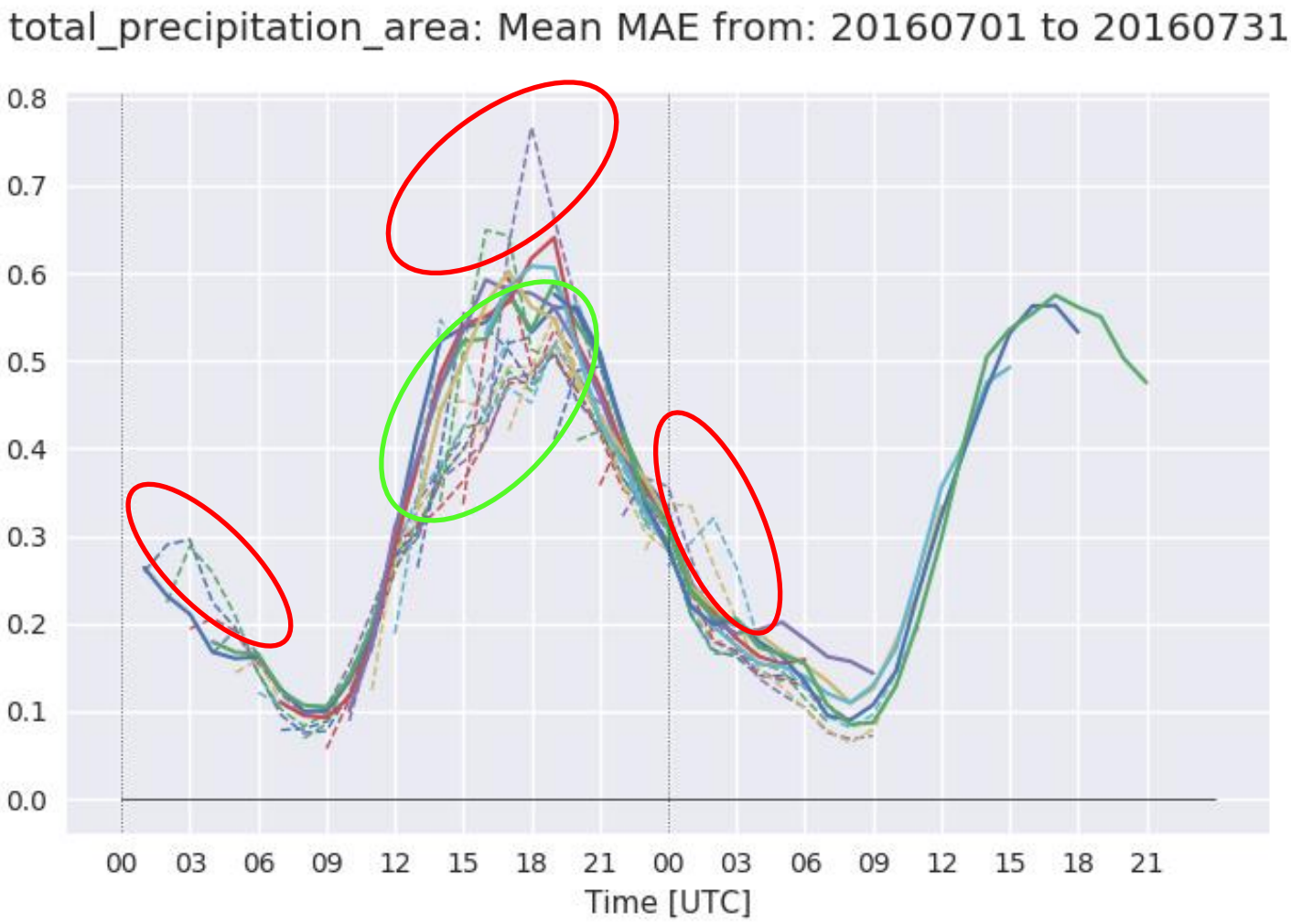
Score to reference (thres:0.1 win: 50)
leadtime [h]
runs init [UTC]
0.16
0.08
0.00
−0.08
−0.16

Percentage of Improvement (thres:0.1 win: 50)
leadtime [h]
runs init [UTC]
100
80
60
40
20
0

Score to reference (thres:0.5 win: 100)
leadtime [h]
runs init [UTC]
0.16
0.08
0.00
−0.08
−0.16

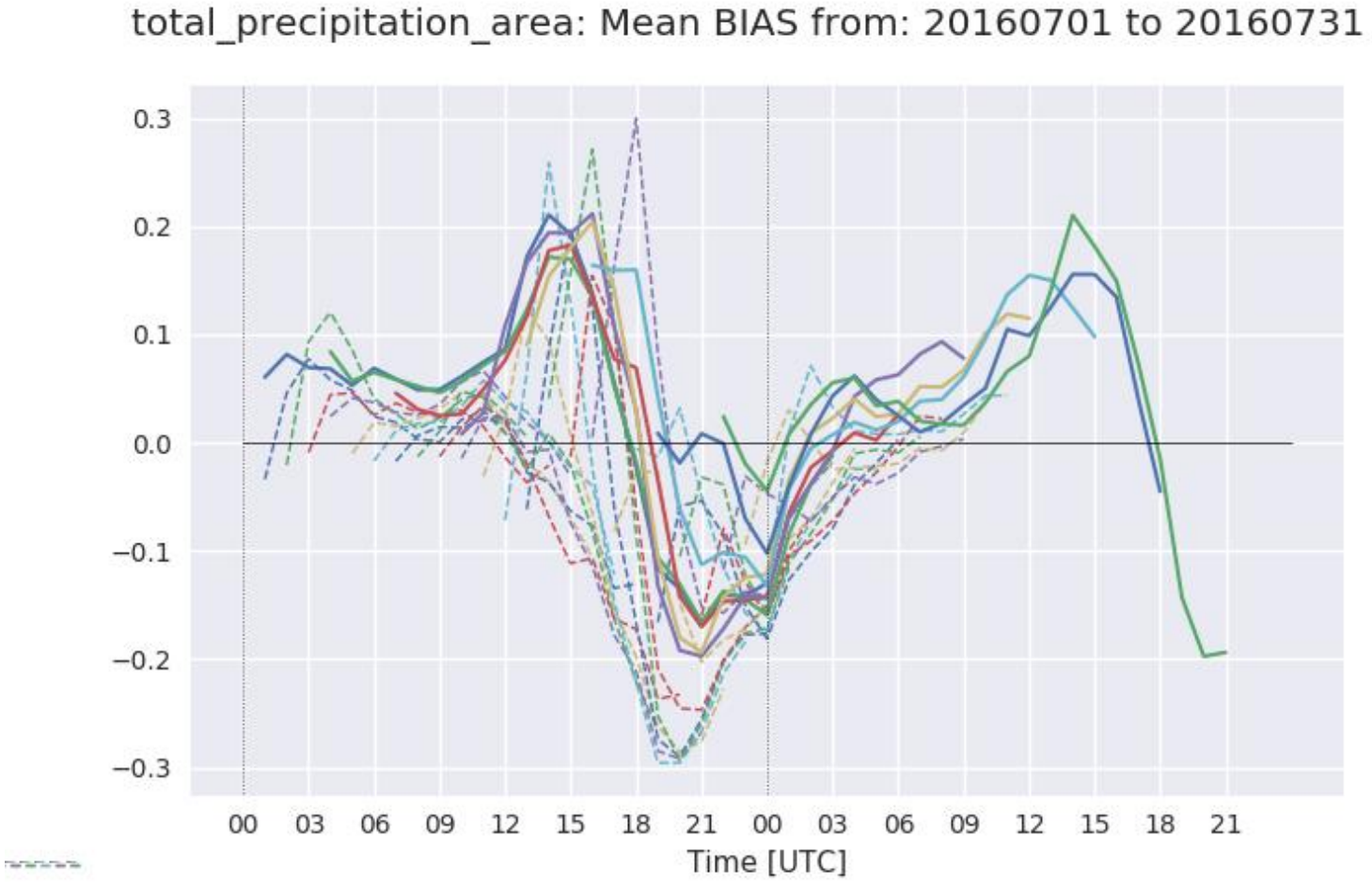
Percentage of Improvement (thres:0.5 win: 100)
leadtime [h]
runs init [UTC]
100
80
60
40
20
0

MAE (area mean)



AROME-OPER: thick lines
AROME-RUC: dashed lines

BIAS (area mean)



AROME-OPER: thick lines
AROME-RUC: dashed lines

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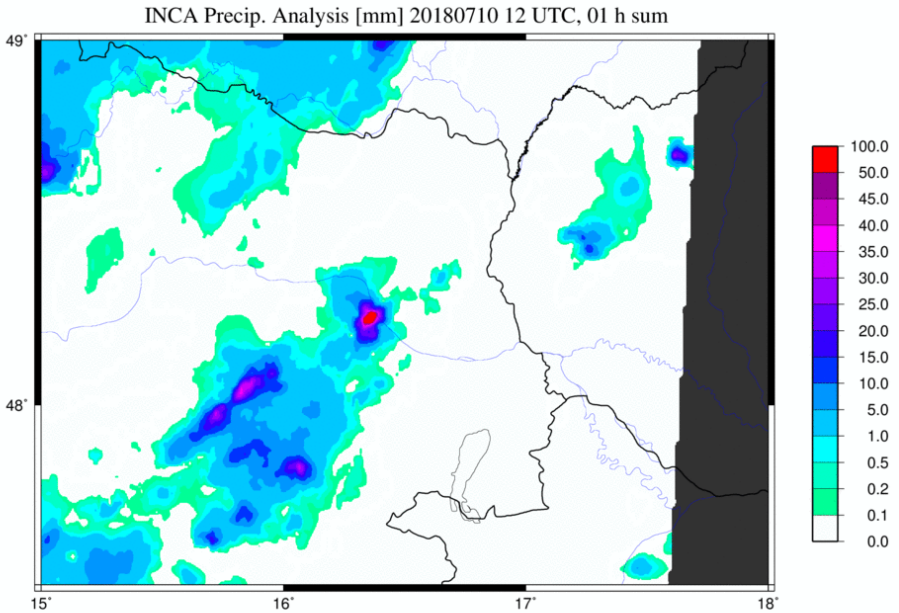

INCA Precip. Analysis [mm] 20180710 12 UTC, 01 h sum
49°
48°
15°
16°
17°
18°
100.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
1.0
0.5
0.2
0.1
0.0

FDDA nudging in AROME (TAWES observations; Liu et al. 2006)

$$DISTANCE' = DISTANCE + R\frac{|z_{OBS} - z_{GP}|}{dzthres = 300m}$$

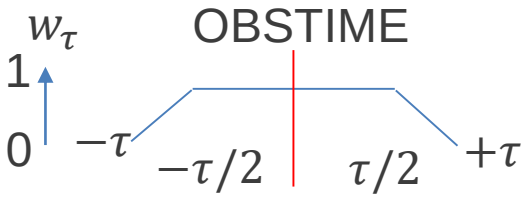
$$w_{xy} = \frac{R^2 0.75^2 - DISTANCE'^2}{R^2 0.75^2 + DISTANCE'^2}\left(\frac{ps_{GP}}{500hPa} + 1\right)$$

$$\frac{\partial x}{\partial t} = \frac{\partial x}{\partial t_{phys}} + G\frac{\sum_i w^2{}_{xyi}(y_{iobs} - x_{model})}{\sum_i w_{xyi}}$$

$$\frac{\partial x}{\partial t} = \frac{\partial x}{\partial t_{phys}} + G\frac{\sum_i w^2{}_{xyi} y_{iobs}}{\sum_i w_{xyi}} - G\frac{\sum_i w_{xyi}\ x_{model}}{\sum_i w_{xyi}}$$

R=20km
G_c=0.00433
τ=6
(namelist switches)

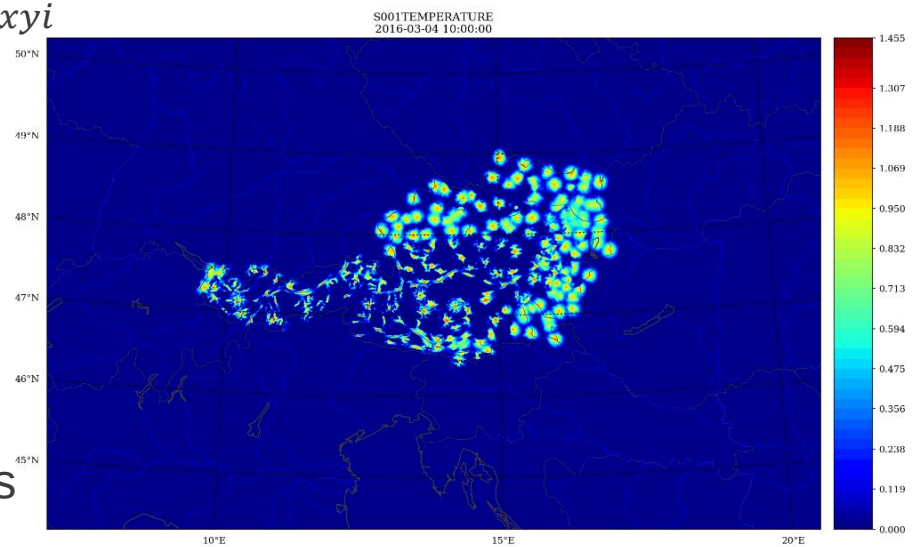
$$G = G_c * w_\tau$$



Observations at: +10 / 20 / 30min

x=T2m/RH2m/U10m

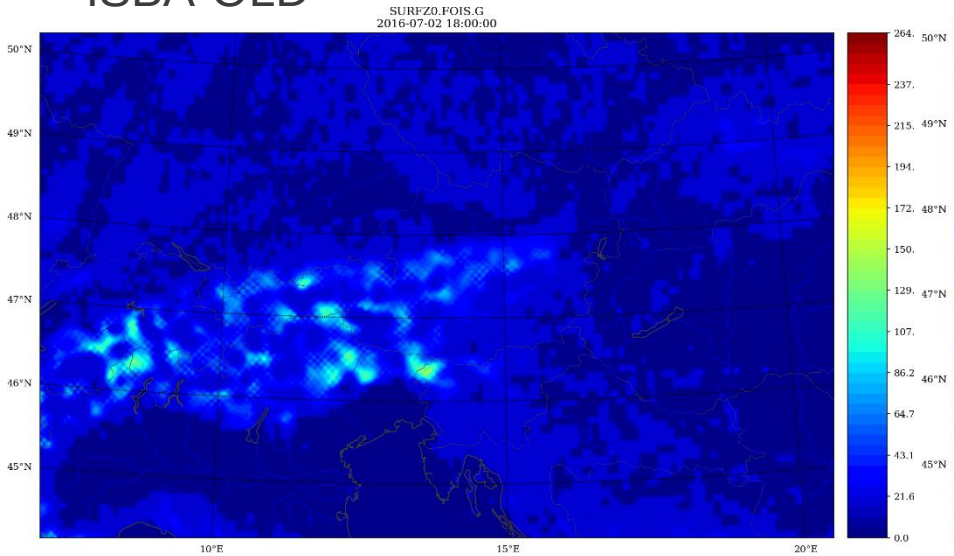
called from apl_arome.F90 after microphysics



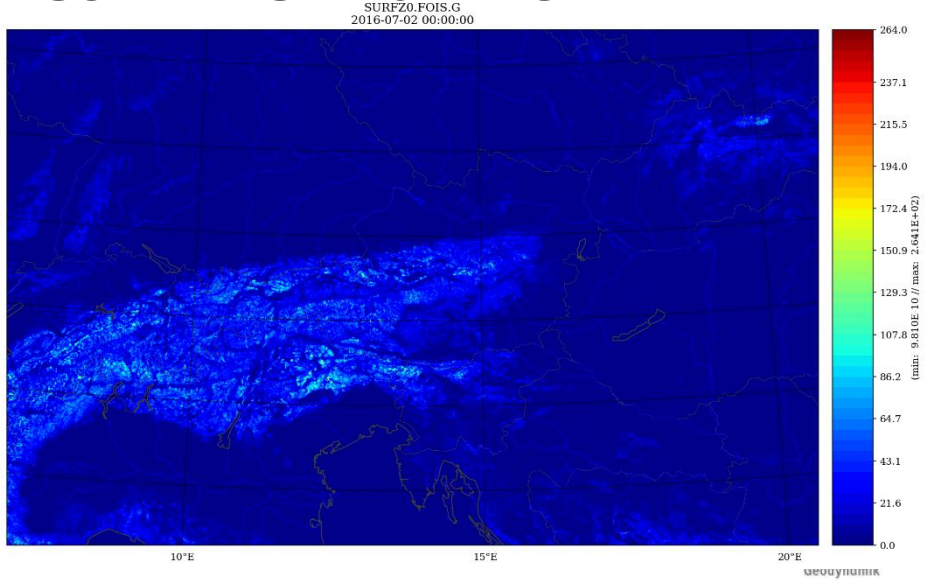
Crashes without abort in minimization - NaN cost function

- GOM arrays NaN (simulated synop observations) due to negative exchange coefficients PCH/PCD(5) in achmttl.F90/acntclstl.F90
- Most crashes avoidable, if synop stations Leiser Berge, Ptuj and Kostelní Myslová blacklisted
- MF-Solution (P. Brousseau) NFPCLI =3 in 927 for old ISBA fields else NFPCLI =1
- old ISBA surface fields (ADDSURF) are still used (roughness, vegetation, emissivity?)!
- Idea: exchange fields with SURFEX values -> all crashes avoided so far

ISBA-OLD



SURFEX: SFXZ0REL*G



Why AROME-Nowcasting?

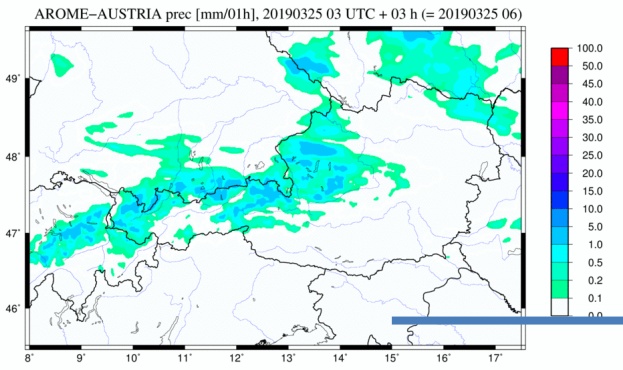
Classical Nowcasting (at ZAMG INCA)

- fast (within few minutes)
- high resolution (<=1km)
- frequent: every 15/5min
- simple combination of observations +NWP
- simple dynamics (motion vectors)
- struggles to predict rapidly envolving non-linear events

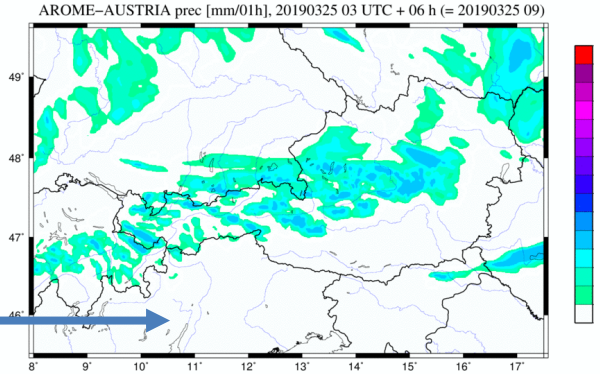
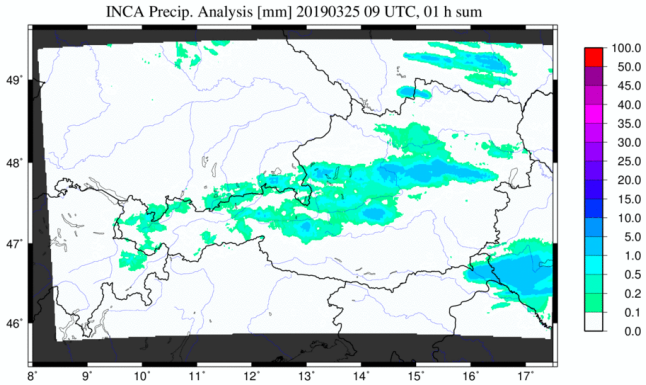
LAM-NWP (at ZAMG AROME 2.5km)

- Slower: available within several hour
- coarser resolved
- less frequent (3 hourly)
- 3D-VAR + OI soil
- Full 3D-dynamics/complex physics
- Long lead time beyond nowcasting range (+60h)

3h FC



6h FCST



reference