Regional Cooperation for Limited Area Modeling in Central Europe

LACE
nwp central europe

Impact of radar reflectivity assimilation

Suzana Panežić, Alena Trojáková and Antonín Bučánek

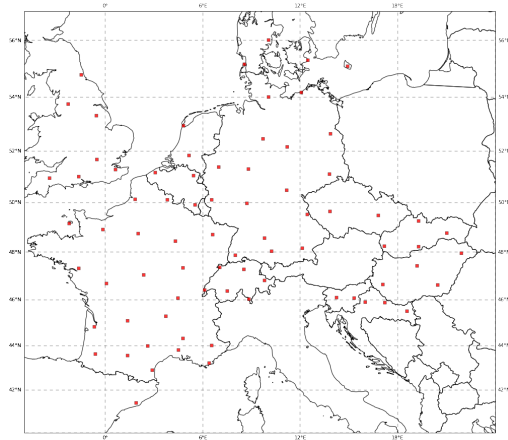
ZAMG DHMZ Czech Hydrometeorological Institute OMSZ IMGW METEO ROMANIA SHMU ARSO METEO Slovenia

Outline

- OPERA radar data
- Model setup
- Code modifications and blacklisting
- 1D Bayesian retrieval - recap
- Case studies
- Drying effect
- Dry observation amount reduction
- Preliminary conclusions

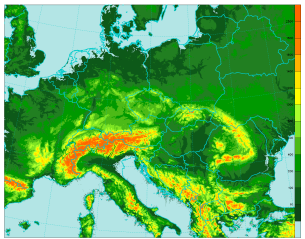
OPERA radar data

- OPERA data (OIFS)
- HOOF v1.9
  - SplitMeasurements = False - corrupted log file naming
- BATOR
  - rejected radars: Poland, Romania, Serbia
  - **Issue:** no TH data in OPERA files



Model setup

- ALARO v1B with prognostic graupels
  - cy43t2ag
  - domain: $\Delta x = 2.3$ km; $\Delta t = 90$ s
  - 87 vertical levels; 1069x853 GP;
  - BlendVar scheme: DF blending (filter at trunc. E102x81) followed by 3D-Var
  - 6h assimilation cycle
  - Assimilated observation: SYNOP, TEMP, AMDAR, SEVIRI, Mode-S MRAR CZ, Mode-S EHS from KNMI, HR-AMV, wind profiler, ASCAT winds

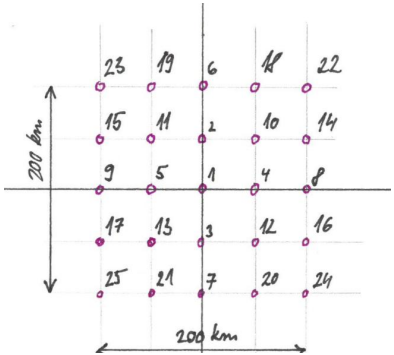


Code modifications and blacklisting

- Code modifications back-phased from cy46t1 to cy43t2 (provided by Maud Martet):
  - reflectivity obs operator: code cleaning & added cloud ice
  - bayesian inversion: more data used in lower layers, low values of double polarized S band radars no longer rejected, bug corrections
  - thinning: too close observation suppression
- Blacklisting
  - Single polarization S band radars - values below 8 dBZ - Romania, Serbia, Croatia
  - X band radars - no radars of this type available in OPERA for non-French LACE radars
  - low elevations for the selected French radars located near mountains - OPERA data ok for QC threshold 0.7 in BATOR

1D Bayesian retrieval - recap

- 1. definition of neighbouring model reflectivity profiles
  - number of profiles
  - boxsize



1D Bayesian retrieval - recap

- 1. definition of neighbouring model reflectivity profiles
- 2. inversion of observed REFL to pseudo observed RH

$$\mathrm{ZREHU(jl,jc)} = \frac{\sum_{\mathrm{jp}} \mathrm{ZHU(jl,jc,jp)} \exp\left(\frac{-\sum_{\mathrm{jc}}\left(O_{\mathrm{refl}}(\mathrm{jl,jc}) - M_{\mathrm{refl}}(\mathrm{jl,jc,jp})\right)^2}{2\sigma^2 N(\mathrm{jp})}\right)}{\sum_{\mathrm{jp}} \exp\left(\frac{-\sum_{\mathrm{jc}}\left(O_{\mathrm{refl}}(\mathrm{jl,jc}) - M_{\mathrm{refl}}(\mathrm{jl,jc,jp})\right)^2}{2\sigma^2 N(\mathrm{jp})}\right)}$$

- σ act as weight in the 1D Bayesian inversion:
  if too large σ the retrieval will be a weighed average of many model profiles (possibly biased towards the mean value);
  therefore the small σ value was originally proposed by Wattrelot

1D Bayesian retrieval - recap

- 1. definition of neighbouring model reflectivity profiles
- 2. inversion of observed REFL to pseudo observed RH
- 3. quality control & thinning
- 4. pseudo observed RH assimilated by standard 3D-Var

Case studies

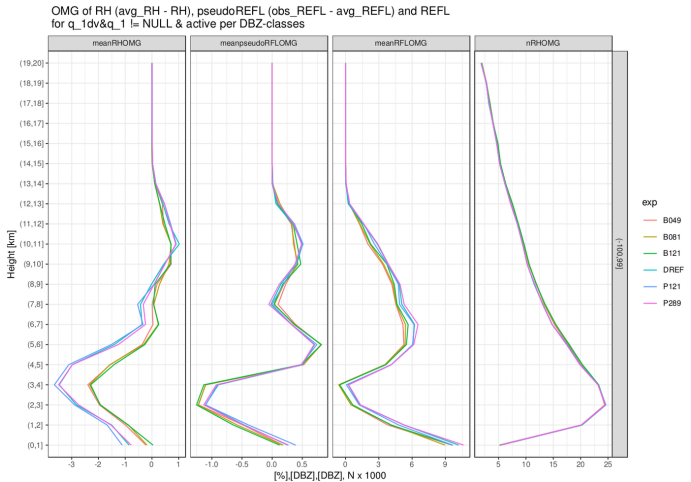
LACE
nwp central europe

- Experiments:

EXP	NOBSPROFS	BOXSIZE	σ [dBZ]	
ALAS				no radar DA
DREF	225	200	5.0	REFL DA
P121	121	200	5.0	REFL DA
P289	289	200	5.0	REFL DA
B121	121	100	5.0	REFL DA
B081	81	100	5.0	REFL DA
B049	49	100	5.0	REFL DA
ZS12	225	200	1.2	REFL DA
ZS02	225	200	0.2	REFL DA

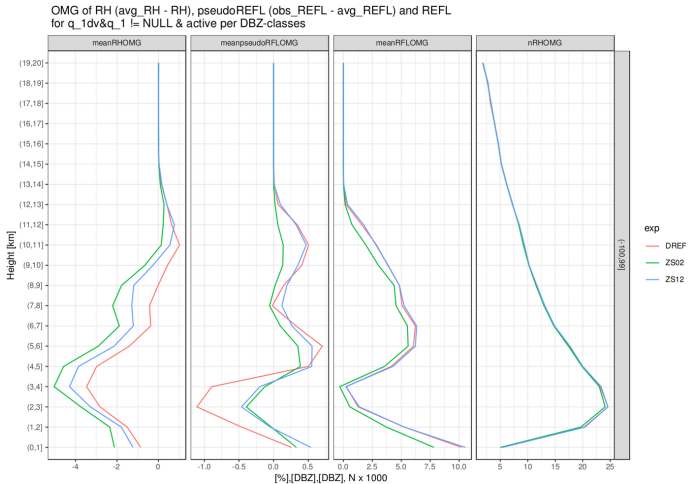
Case studies

- 12.08.2020. 12UTC - 14.08.2020. 18UTC DA cycle
- Low sensitivity on number of profiles
- Some sensitivity to the selection box size



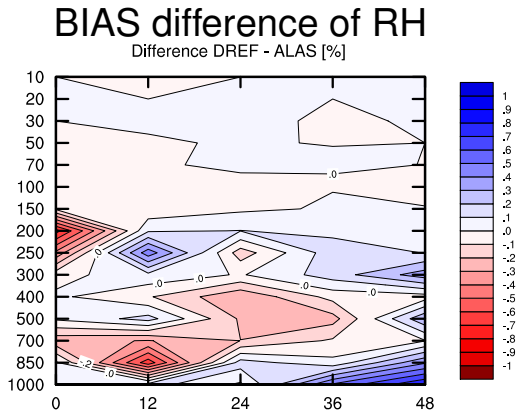
Case studies

- 12.08.2020. 12UTC - 14.08.2020. 18UTC DA cycle
- Largest sensitivity on observation error
- Drying effect in all experiments



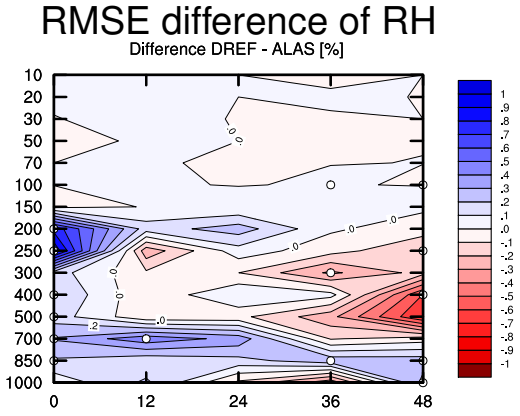
Drying effect

- 14.- 29.08.2020 00UTC production
- Drying of the atmosphere (red)



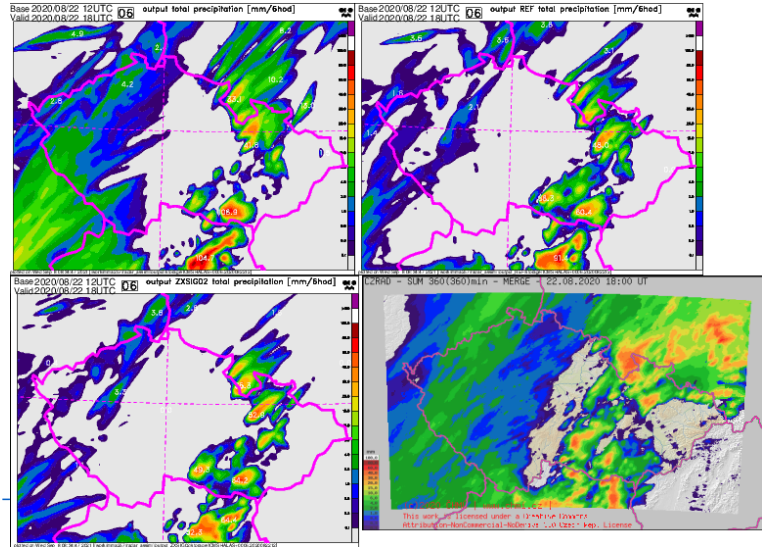
Drying effect

- 14.- 29.08.2020 00UTC production
- Degradation of the forecast (blue)



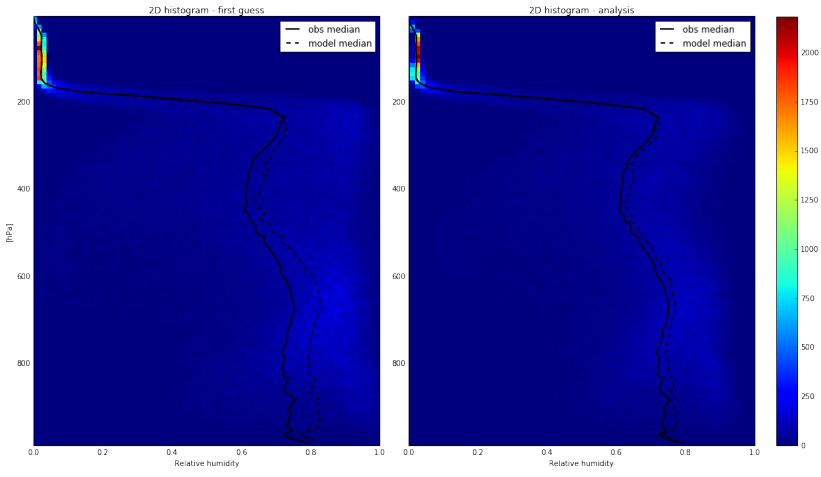
Drying effect

- Precipitation removed by radar reflectivity inclusion in data assimilation (ALAS, DREF, ZS02 compared to precipitation estimation radar+gauges)



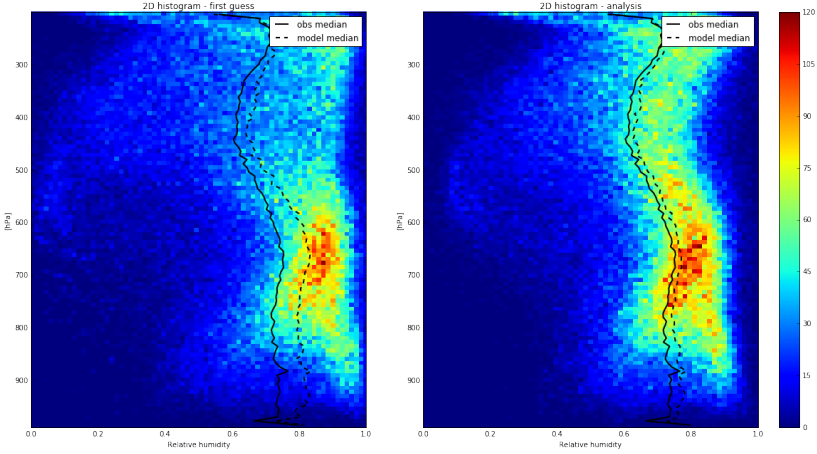
Drying effect

- Dry obs (flgdyn=0)
- too many obs above 200hPa ! (to be removed ?)



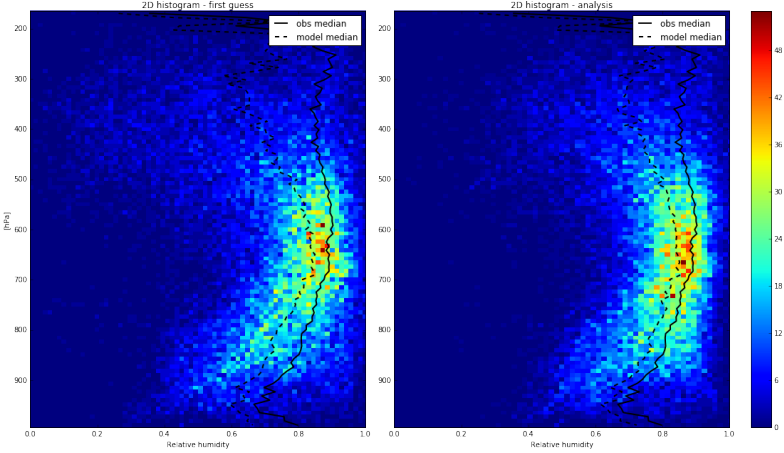
Drying effect

- Dry obs (flgdyn=0)



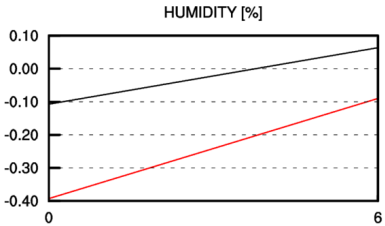
Drying effect

- Moist obs (flgdyn=8)

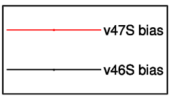


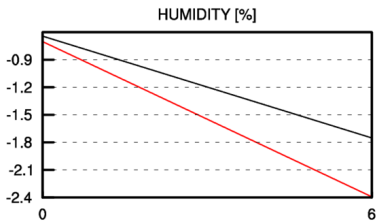
Drying effect

- Dry case
- Drying even when there is no precipitation in the domain

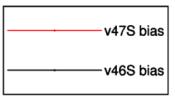


Period: 20210824...2021082
Network: 0UTC
Level 850 mb



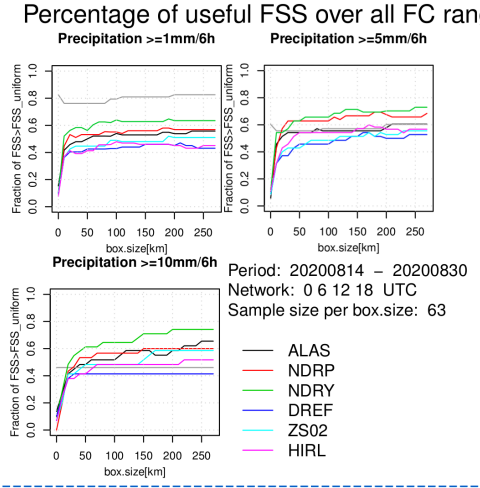


Period: 20210824...20210825
Network: 0UTC
Level 1000 mb



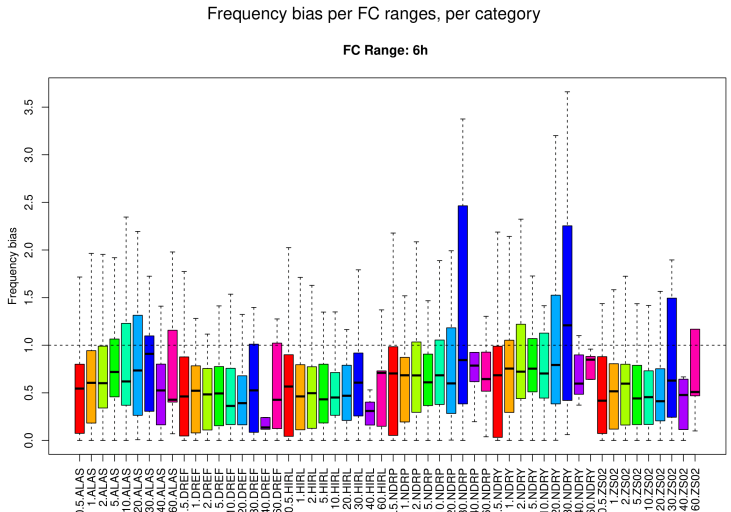
Dry observation amount reduction

- Additional experiments:
  - NDRY
    - All dry pseudo-observation (flgdyn=0) removed
  - NDRP
    - All completely dry (obs) profiles removed
  - HIRL
    - Modified HIRLAM solution which expects that there is low precision of detection threshold or problem in model obs operator which is unable to produce low enough values ($M_{refl} < 0$)



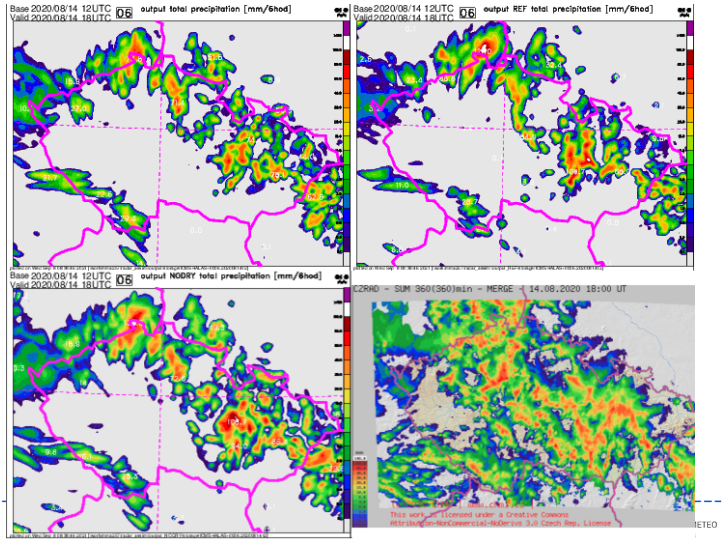
Dry observation amount reduction

- More precipitation is kept in the system
- Spurious convection with large amounts of precipitation



Dry observation amount reduction

- More precipitation is kept in the system
- Spurious convection with large amounts of precipitation



Preliminary conclusions

- Small sensitivity to the selection box size
- Smaller observation error shows a better fit of pseudo-observed reflectivity to observation, but a larger bias of pseudo observed relative humidity
- Drying effect in lower troposphere and mixed signal above
- Reduction of dry observation exp. showed some sensitivity but no sensible solution for the drying effect was found
- Next steps: radar detection threshold in BATOR should be revisited, modification of weights in the inversion routines, investigate radar observation operator

Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Thank you for your attention.

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