Regional Cooperation for
Limited Area Modeling in Central Europe

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ALARO tests of radar observation operator

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Outline

- Introduction
- OPERA radar data
- Experiments and results
- Conclusions

ALARO tests of radar obs operator

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- radar reflectivity observation operator described in Wattrelot et al. (2014)
- The Rayleigh method is used to compute the backscattering of precipitating hydrometeors. The hydrometeor size distribution is the same as used in the AROME microphysical scheme ICE3 (Pinty and Jabouille (1998)). ICE3 considers cloud water, rain, graupel, snow and primary ice.
- AROME obs operator implementation uses only rain, snow and graupel
- ALARO microphysics scheme was inspired by Lopez (2002). It considers six species - dry air, water vapor, suspended liquid and ice cloud water, rain, and snow. Introduction of prognostic graupels was investigated by Bochenek (2017)
- Aim of the study is to investigate the use of the reflectivity obs operator in ALARO, in particular effects of adding graupel in the ALARO microphysics on simulated radar reflectivities
- LACE stay in Ljubljana, 24/2/-13/3/2020 in collaboration with Benedikt Strajnar (ARSO)

Prognostic graupels in ALARO

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- **prognostic graupels were implemented locally following Bochenek (2017)**
- **ALARO with graupels (left) provides qualitatively similar forecasts (similar structures & slightly smaller intensities)**

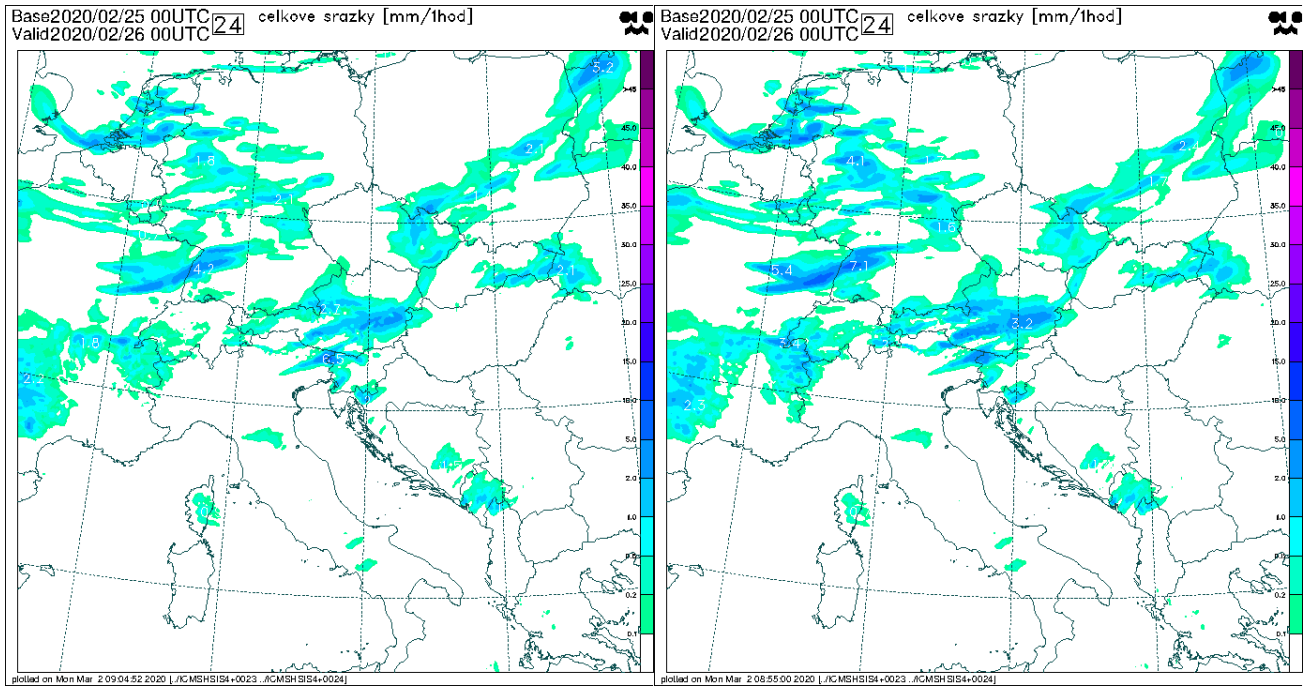

Figure 1: 1h precipitation forecast for 25 February 2020 00UTC for lead time of +24h for ALARO with prognostic graupels (left) and reference without graupels (right).

OPERA radar data

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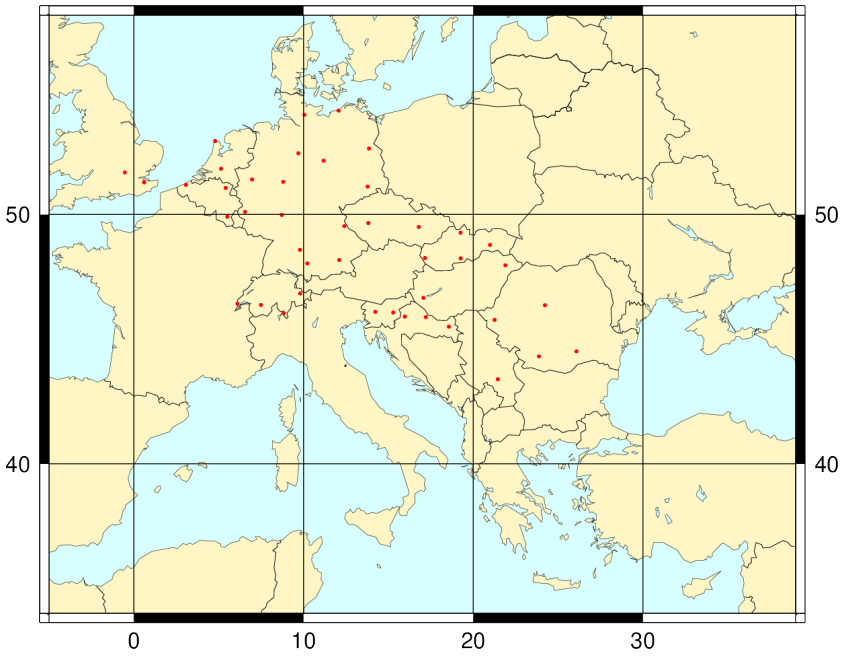
- Volume data provided via OPERA Internet File Server (OIFS) with quality flags (beam blockage, Bropo module, satellite filter and total quality index)
- HOOF (version 1.6) is not able to process data if one or more QC flag is missing. HOOF adaptations under development by Peter Smerkol
- summer test period 30 July - 15 August 2019
- 45 radars from BE,CR,CZ,DE,HU,NL,RO,SZ,SK,SI,CH,UK
- Issues:
  - no data from FR, PL due to missing beam blockage flag
  - few BATOR crashes for DE radars to be investigated



NWP model configuration (ALARO/SI)

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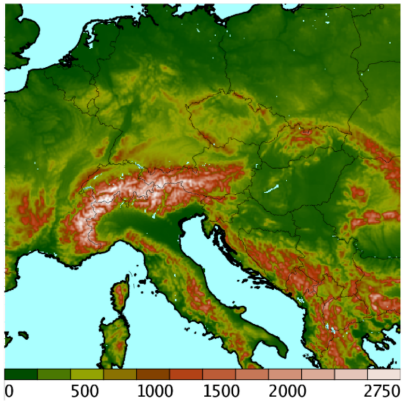
- **ALARO-v1B cy43t2**:
  - domain: $\triangle$x 4.4km, 432x432GP
  - 87 vertical levels, mean orography
  - time step 180s
  - space consistency coupling ECMWF (no DFI)



- **Upper air analysis** – 3D VAR scheme
  - 3h assim cycle
  - Assimilated observations - SYNOP, TEMP, AMV, AMDAR, Mode-S MRAR/EHS SEVIRI, AMSU&MHS, IASI, and ASCAT
- **Surface analysis** – OI based on SYNOP (T2m, RH2m)
  - SST from ARPEGE

Experiments and results

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- **Two experiments with and without prognostic graupels (radgt1/radgf1)**
- **Both experiments initialized from the oper forecast valid for 30 July 2019 0UTC, reflectivities were assimilated in passive mode.**

Experiment name	prognostic graupels	graupel initialization
radgf1	no (LGRAPRO=F)	zero values (YG_NL%NREQIN=0)
radgt1	yes (LGRAPRO=T)	guess values (YG_NL%NREQIN=1)

- **Graupel initialization needs special attention even in case of no graupels (LGRAPRO=F). Missing graupel namelist keys (YG_NL%LGP, YG_NL%NREQIN,...) leads to wrong results ! This should be better understood/fixed.**
- **Statistics of REFL data**

Experiment name	Number of REFL [N]		Mean OMG [DBZ]		STD OMG [DBZ]	
	Total	Active	Total	Active	Total	Active
radgf1	23398441 (100.0%)	(5.37%)	-0.41	-2.06	8.67	14.73
radgt1	23398441 (100.0%)	(5.51%)	-0.37	-1.77	7.76	13.15

Table 1: Number and OMG statistics for reflectivity for period of 30 July - 15 August 2019.

Experiments and results

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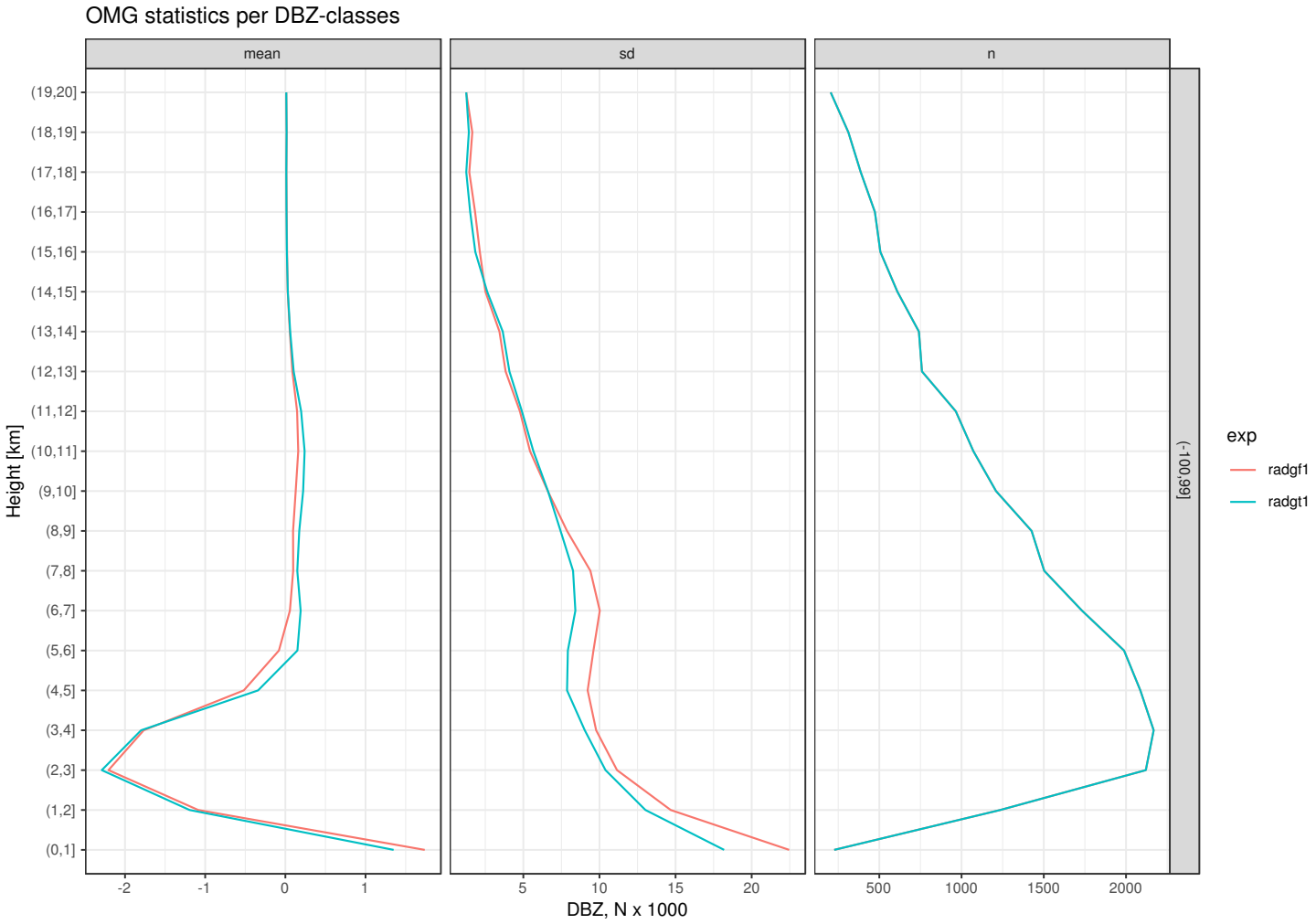
- **Reflectivity innovations (OMG) separated by**
  - **height**
  - **distance from the radar**
  - **reflectivity thresholds**

DBZ thresholds	rain class
(-100,0]	? noise
(0,10]	hardly noticeable/mist
(10,35]	light rain
(35,45]	moderate rain
(45,100]	heavy rain

Results: ALARO no-graupel / graupel



Results: ALARO no-graupel / graupel

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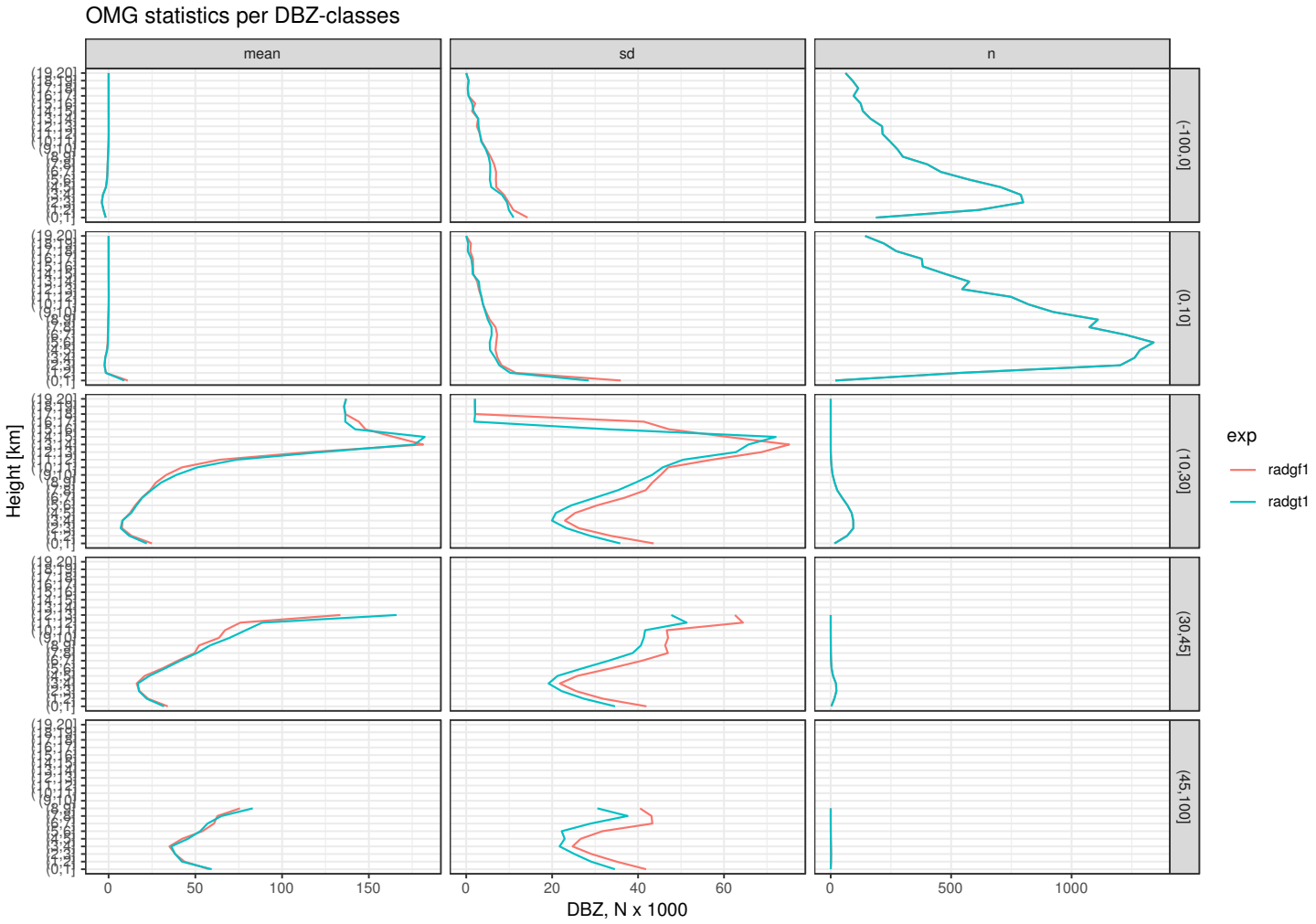


Results: ALARO no-graupel / graupel

- **small differences in OMG histograms, except decrease of secondary mode around 150dBZ for the moderate rain category**

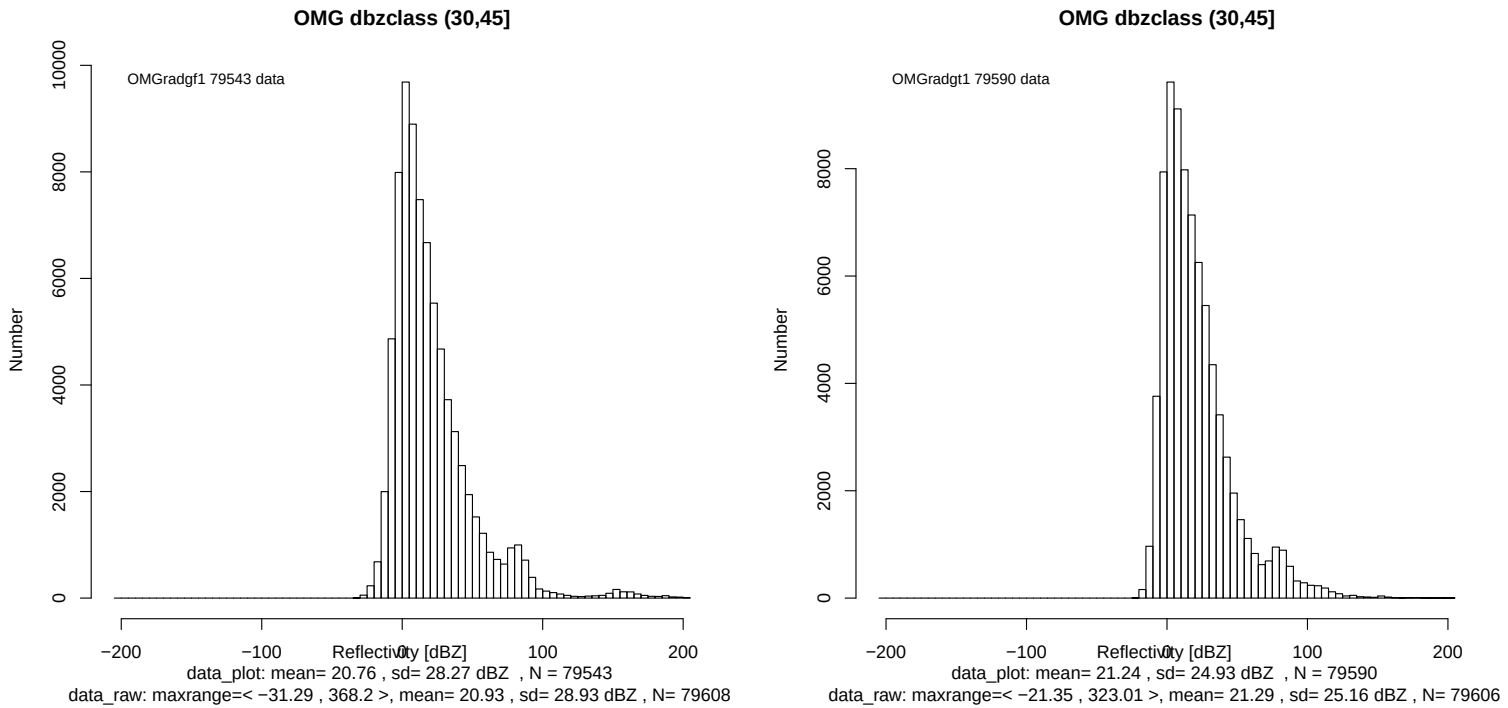


Figure 2: Histograms of reflectivity innovations for moderate rain (30-45 DBZ) category for ALARO without (left) and with graupels (right).

Results: ALARO no-graupel / graupel

- large number of reflectivity innovations (89%) equal to zero which is unrealistic

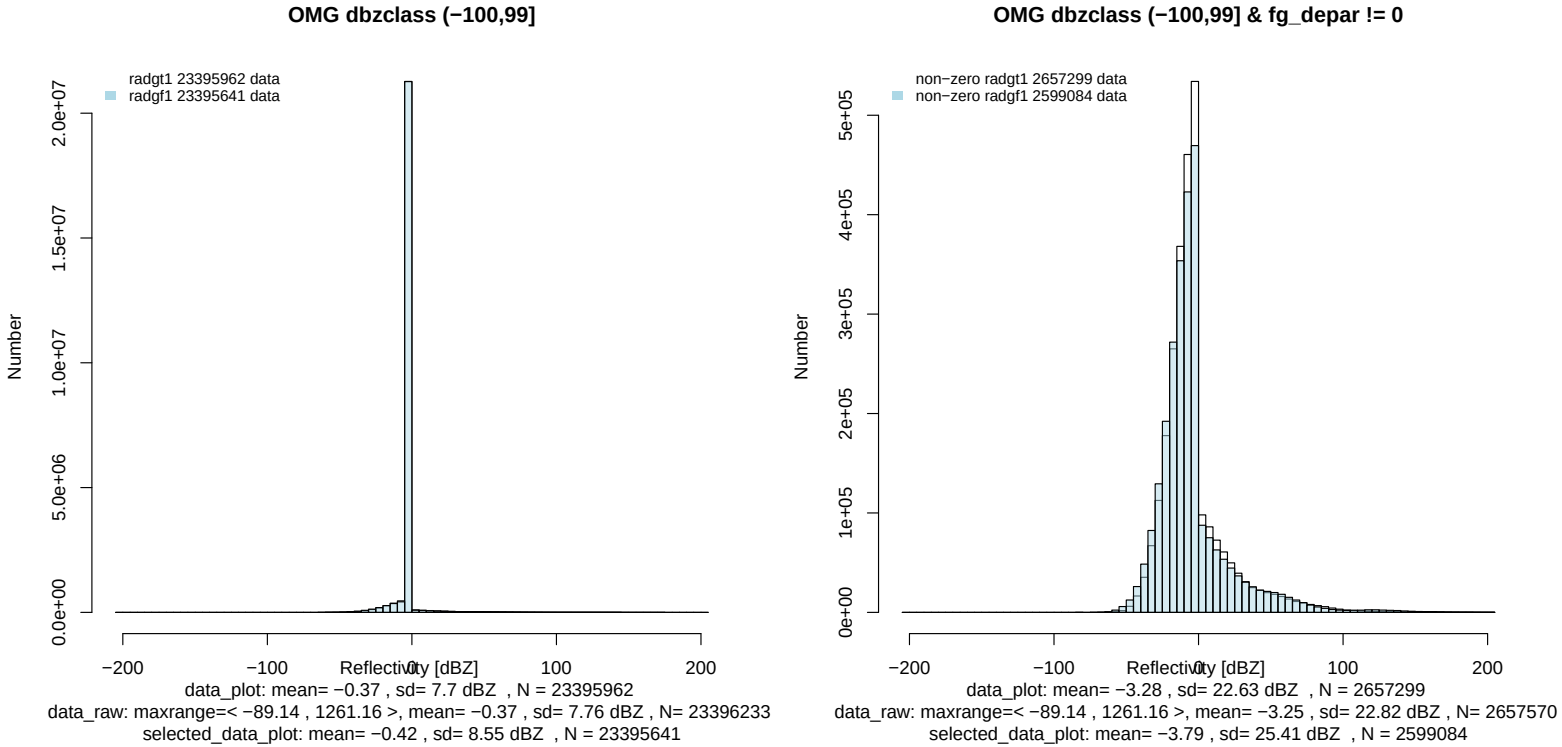


Figure 3: Histograms of reflectivity innovations for all DBZ categories (all values on left and non-zero values on right panel) for ALARO without (blue) and with graupels (white).

Experiments and results II

- **ALARO results compared with AROME France over a common subdomain (DE)**
  - this reduced the sample to 25%

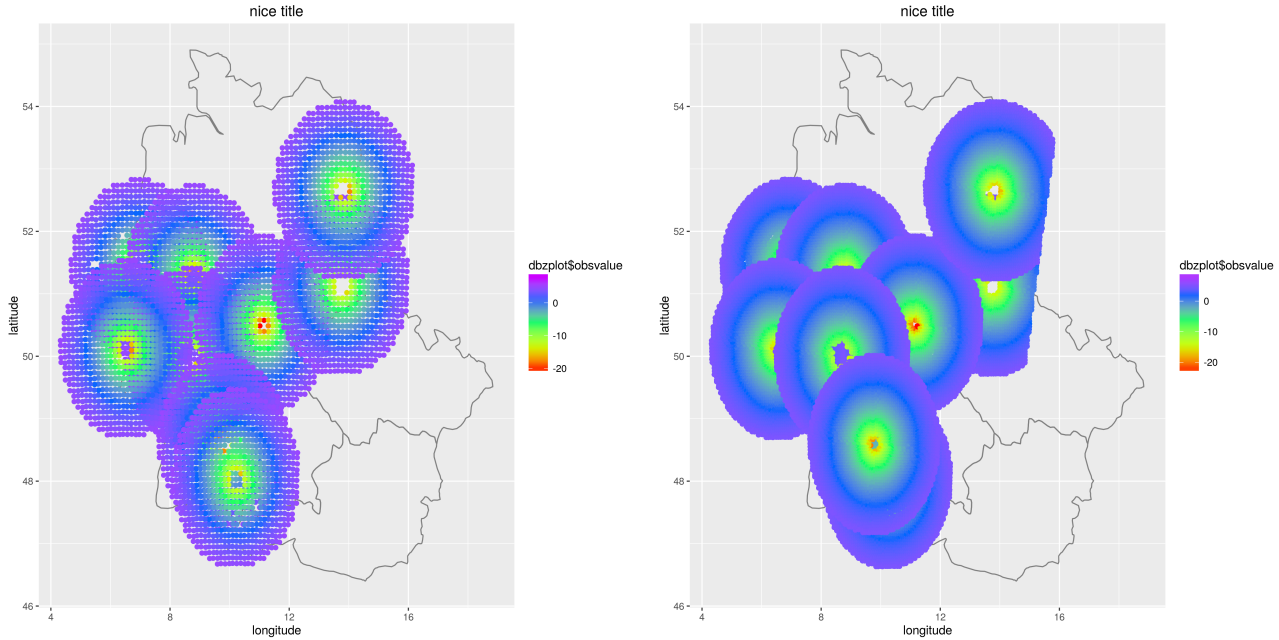
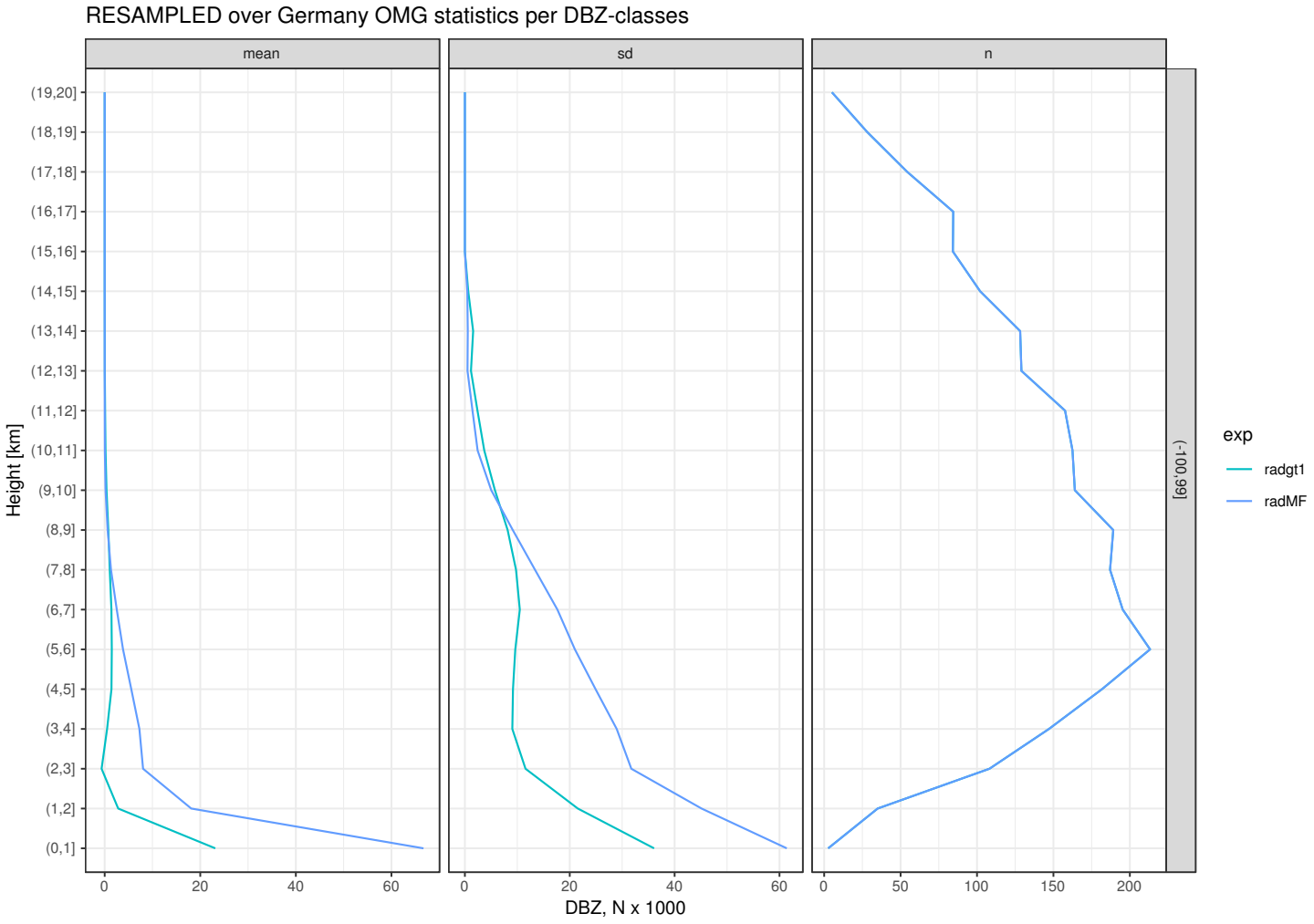


Figure 4: REFL ALARO (left) and AROME-FR (right)) for 30 June 2019 06UTC.

- **to eliminate different resolutions the data at the same locations were selected by**
  - this further reduced the sample by 60%

Results: ALAROgraupel/AROME-MF



Results: ALAROgraupel/AROME-MF

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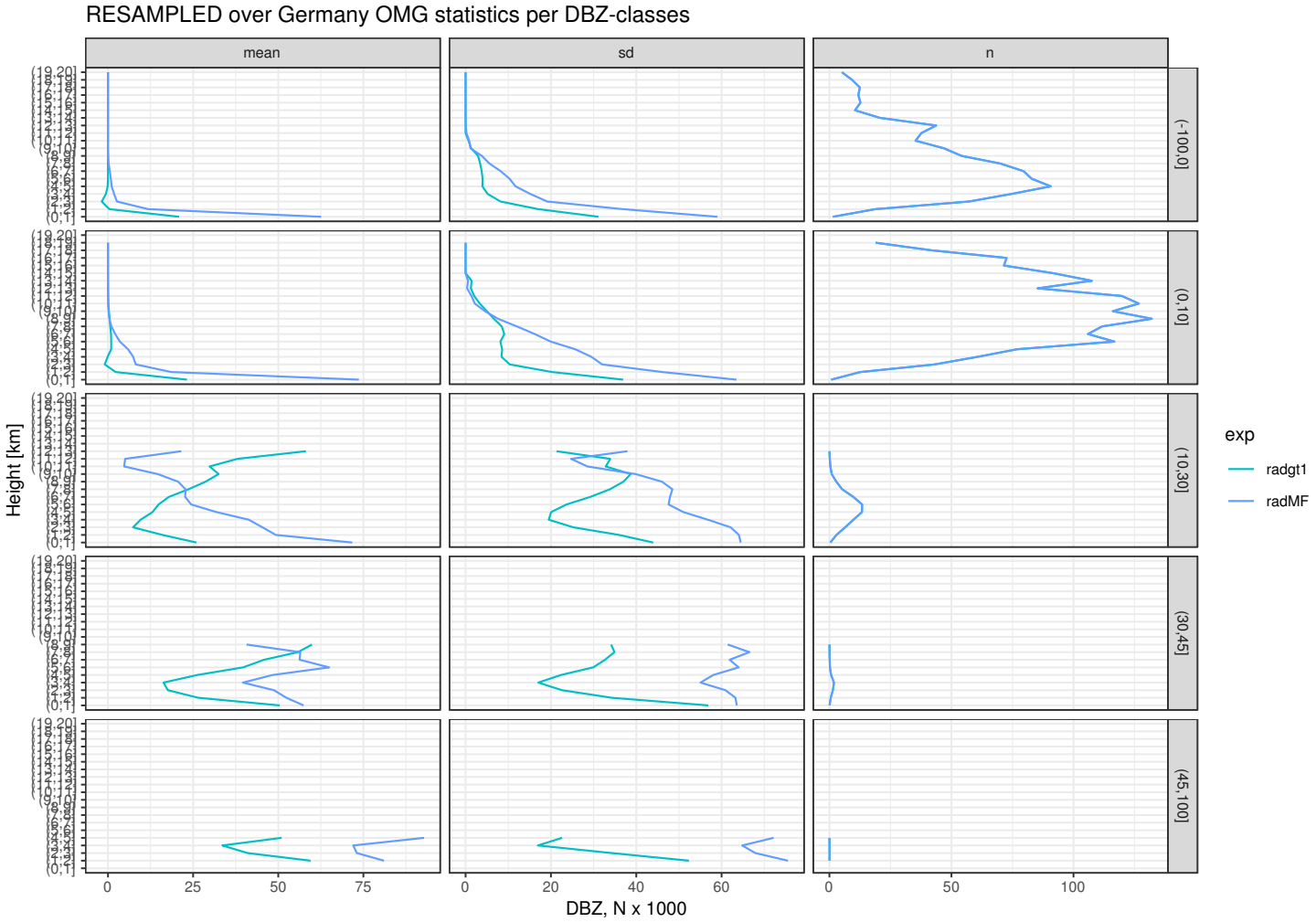

Conclusions

- **The prognostic graupels in ALARO are still considered as a very fresh development which needs detailed evaluations in NWP context.**
- **Adding prognostic graupels in ALARO miscrophysics has positive effect on simulated reflectivities, namely by a small reduction of STD of reflectivity innovations.**
- **The graupel initialization to zero is necessary for the reflectivity obs operator even in case of ALARO without prognostic graupels to avoid extremely high simulated reflectivities.**
- **The comparison of ALARO and AROME-FR reflectivity innovations provided qualitatively similar statistics which give us more confidence for further testing of radar reflectivity data assimilation within ALARO configuration.**

End

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Thank you for your attention !

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