Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Processing of radar reflectivities in screening

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Outline

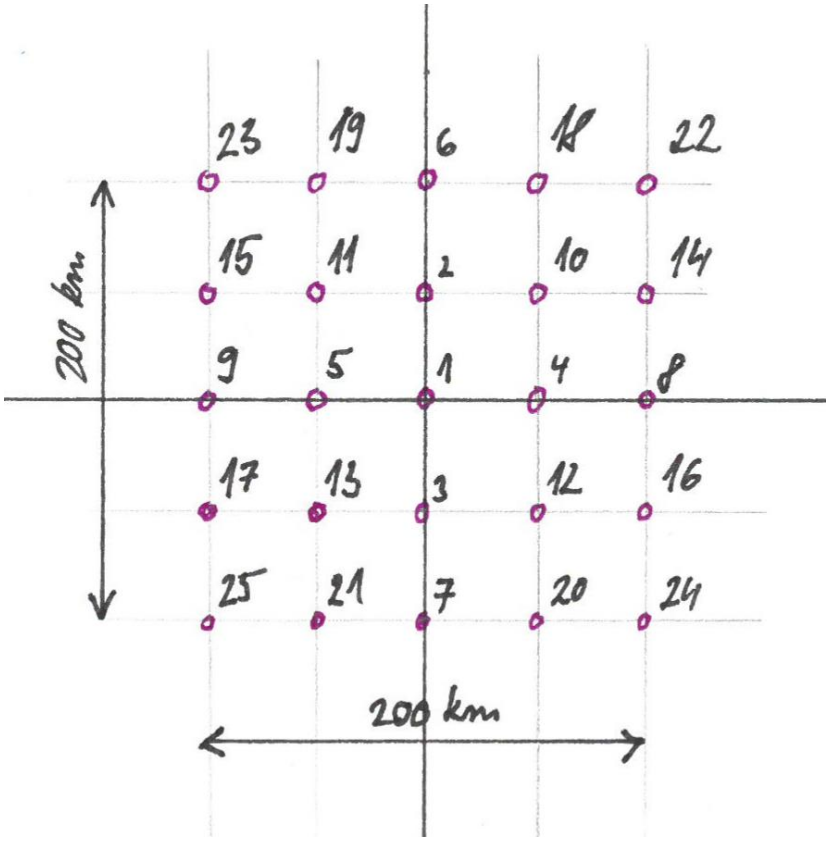
- Stay at ZAMG
  - Model reflectivity profiles
  - Inversion of reflectivity to relative humidity
  - Removal or radar obs column and sign consistency check
  - Thinning
- Correlations test
- Comments on open issues
- Conclusion

Strict distinction - Column vs. Profile

- **The column** denotes all elevations of one observation report (i.e. set of observations approximately above one horizontal point).
- **The profile** denotes all elevations of one of model simulated profiles.

Model reflectivity profiles

- Routine: **radar_profs.F90**
- Output: Array of lats, lons of simulated profiles
- For each observation column is defined NOBSPROFS (namelist NAMNPROF) model profiles
- NOBSPROFS should be square of some odd number!! We use 225 profiles adopted from Météo-France (MF used 81 profiles until cy40t1)



Inversion of reflectivity to relative humidity 1

- Routine: **inv_refl1dstat.F90**
- First some quality control,
  - Removal of dry obs column (undetect) where model is also dry at obs column. Removal of obs with low values, obs below last model level and above first model level, French C Band radar removal.
- For dry obs redefinition of model sim refl
  - If [flgdyn==0 and sim refl < obsvalue] then sim refl=obsvalue
- If **sim refl not defined at obs column** (first profile) then **no RH**

Inversion of reflectivity to relative humidity 2

- Computation of humidity column
  - The observed humidity column is computed as weighted average of humidity profiles (225). The weight for a sim profile is defined as Gaussian function of difference of obs reflectivity over all obs elevation to model sim reflectivity. This means the larger the difference is the lower the weight is for that profile.

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

Inversion of reflectivity to relative humidity 3

- **Found bugs (possible bugs)**
  - Humidity interpolation stops at level 10 not at the top, line 153 in cy43t2_bf10
  - At final consistency check for humidity super saturation the value 120 should be changed to 1.2, line 264 in cy43t2_bf10
  - not real bug but suboptimal, line 263 in cy43t2_bf10
    ZREHU(JLEN,JCOUNT)<0._JPRB
    This is fulfilled even ZREHU==RMDI (-2147483647) which was set earlier in the process. It is not necessary to go in this if! So it would be better to make (ZREHU(JLEN,JCOUNT)<0._JPRB .AND. ZREHU(JLEN,JCOUNT)!=RDMI)

Removal of RH column & OMG sign check

- Routine: **flgtst.F90**
- Purpose: to transform datum/report flag information to a status
- Check of sign OMG RH vs OMG reflectivity
  - if [sign(OMG RH) /= sign(OMG refl)] then reject obs
- Removal of Dry columns
  - if [OMG reflectivity equal zero (fg_depar=0) for all observations in one obs column] then reject obs column
  - **I think that all dry observation where fg_depar=0 should be removed (explained later)**

Thinning 1

- Routine: **new_thinn.F90**
- RMIND_RADAR = default cca 4km, Min distance between obs, RFIND_RADAR = default cca 8km, Avg distance between obs
- Two loop, first rmind size boxes, second rfind size boxes
- Obs are ordered in a box by thinningtimekey, obs with the lowest thinningtimekey is selected
- Obs nearer to the radar, obs columns with more elevation and with lower azimuth are preferred

Thinning 2

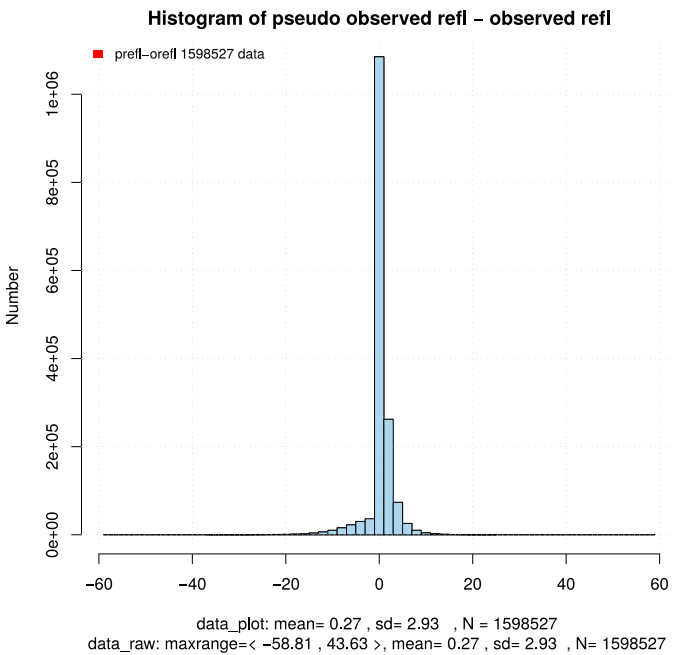
- Thinning is **not reproducible** when two or more ODIM files from the same radar are processed by Bator!
- **This can easily happen if you use HOOF in split mode and put all outputs to bator.**
- All reflectivity obs have the analysis time.
- Bator reads one ODIM file at a time then selects observations nearest to the analysis time (selects from more scans in one file). But if two file from the same radar enters bator that we have two observations with the same time and possibly place which makes troubles in thinning.

Thinning 3

- I do not like that thinning prefers observation columns with more elevations since it can easily happen that half of those elevations are rejected by QC.
- I do propose to prefer observation columns which have more active elevations. (pre_thinn_rad_reflec.F90:L248)

Correlation test

- Wattrelot et al. (2014) proposes to look on differences between pseudo-observed reflectivity and observed reflectivity. Large differences indicate that 1D Baysian inversion is not able to provide pseudo-observation consistent with observations.
- Displayed histogram contains only data passed by QC while Wattrelot histogram is without QC



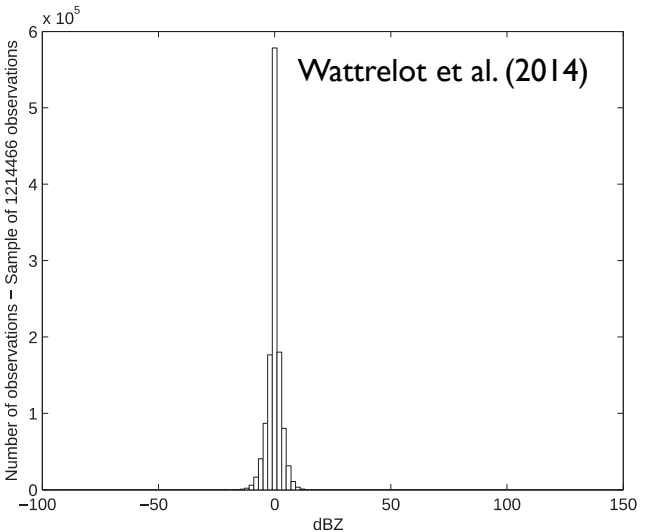
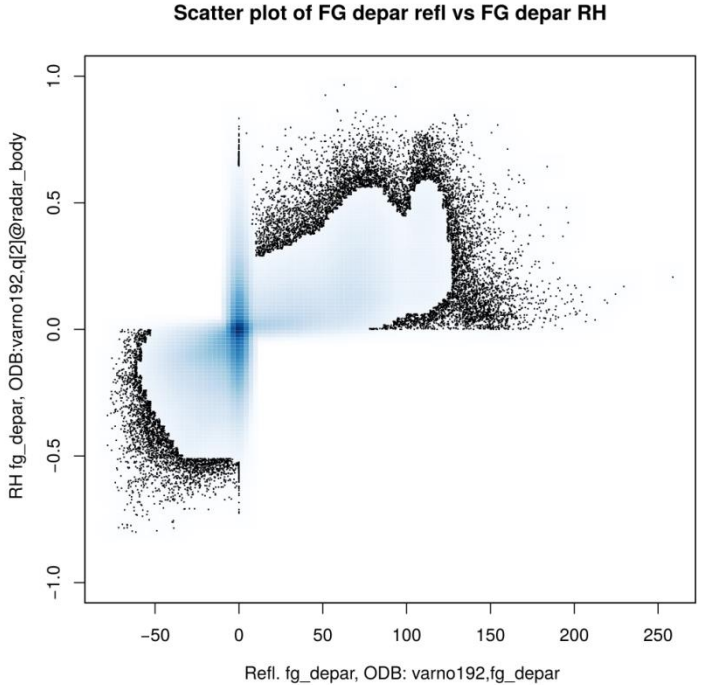


FIG. 4. Histogram of analyzed ref ectivity minus observed ref ectivity from 2100 UTC 22 Feb to 0000 UTC 28 Feb 2010 (42 assimilation cycles) (OREFLEC experiment). The sample comprises 1 214 466 observations entering the 1D Bayesian inversion. The correlation between the analyzed ref ectivity and the observed ref ectivity is 0.9678.

Correlation test 2

- Scatter plot of RH fg_depar vs. Refl. fg_depar has more less similar shape to Wattrelot et al. (2014) but with much higher values of Refl. fg_depar
- First and third quadrant is empty due to QC



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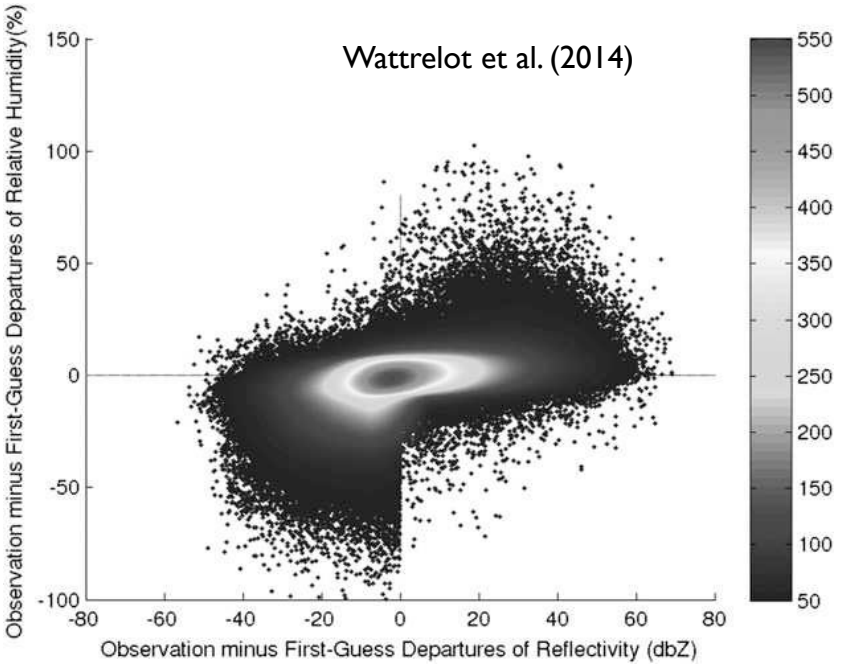

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Bator - MF cy43t2_op4.03

- **Bator used in tests: MF cy43t2_op1.12**
- **Do not change HODIM%resolution in namelist of Bator!**
  - A minor bug in BATOR was spotted, the formula for “distcrit” computation is only correct when HODIM%resolution = 1000 is set in bator namelist! See subroutine bator_decodhdf5_mod.F90:L1981 (cy43t2_op4.03)
- Bator MF cy43t2_op4.03: New handling for no-rainy observations.
  - Only observations which have minimum detectable signal <= 0 are allowed for assimilation (before it was not restricted).
    Meteo-France (personal communication with Maud Martet) claim that they use “no-rain” only when radar noise is not to high (0dBZ). This is about 100km from French radars. MF claim that it is good compromise in order to use the "no-rain" information but not where the radar sensibility is too high. The threshold was not tested for other EU radars.
- So for LACE is questionable if we would like to adopt the same setting or not.

Assimilation fg_depar=0

- The other problem no yet resolved is assimilation of dry reflectivity observations which have fg_depar==0
  - This can only happen when model is dryer than radar (i.e. detection threshold) at that observation location and elevation. Then the code redefines the model reflectivity, which results in fg_depar=0.
  - But the RH fg_depar is non zero, it can be positive or negative since it relies on comparison of pseudo-observed RH with model RH.
  - **Is the pseudo-observed RH computed correctly in this case? Probably no.**
  - Analysis of fg_depar=0 result in positive or negative corrections to model RH.
- Since radar is measuring “nothing” and model is even dryer it would be preferable to discard those observation from assimilation (My feeling).

Summary of issues (open questions)

- Minor bugs in reflectivity inversion
- Thinning no reproducible for more ODIM files from one radar
- Thinning prefer more elevations instead of more active elevations in obs report
- Bator MF cy43t2_op4.03: New handling for no-rainy observations (slide 14)
- Assimilation of fg_depar=0

Conclusion

- Processing of reflectivity observation in screening was clarified
- A few open issues where identified
- A few testing proposals:
  - Sensitivity tests on search radius for model simulated profiles
  - Sensitivity tests on number of profiles, sigma_refl
  - Superobing
  - Understand/test vertical or slanted observations

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Thank you for your attention.

PS: Stay report is available on RCLACE web
http://www.rclace.eu/File/Data_Assimilation/2020/repStay_ABucanek_RadarThining_ZAMG_202002.pdf

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