

Second reply to referees - nhes-2023-103 - "Assimilation of surface pressure observations from personal weather stations in AROME-France"

Parts added to the manuscript are in **blue** and deleted parts are in **red**. Line numbers (L) in our replies are those of the version after the first revision.

5 Reply to anonymous referee #1

General

I would like to thank the authors for adding Appendix A. The difference in length scales - 40 km vs 200 km is dramatic - and I feel this should be mentioned in the summary. My detailed comments below are mainly suggestions for improving the wording, with some requests for clarification.

- 10 > We thank the referee for the remarks and advices. Indeed, the difference in length scales between 3DVar and 3DEnVar DA scheme is huge. We have mentioned it in the summary (L530): **This reduction of length scale from 200 km in 3DVar to 40 km in 3DEnVar for a single observation is illustrated in Appendix A**

line 9: 'reduces by -10.3 % the root-mean-square departure' remove minus sign before 10.3 %.

> We have corrected it.

- 15 *10: 'improvement is observed up to 9 h of forecast' - '... observed over the first 9 h of the forecasts' (or perhaps 'the first 6-9 h' for eg)*

> We have corrected it.

17: 'accurately modelling' - 'accurately estimating'

> We have corrected it.

- 20 *35/36 The RBON/GBON sentence now seems awkward to me. Could say 'Regional/Global Basic Observing Networks exchanged via the WMO Global Telecommunication System'*

> We have corrected it.

144 'informs us of the concordance between both the ...' 'concordance' is an unusual word in English, perhaps 'provides a comparison between the ...'

- 25 > We have corrected it.

152 'screening' is there any check on the height difference between the station and the model? (It can be large in mountainous areas.)

> To answer this good question, the following sentence has been added L156: **Two other screening steps that are important for mass observations (surface pressure and geopotential height) include checks for missing station altitude, and compliance with WMO observation standards: if the reported observation level is far from the true station level, σ_o is inflated (more details in Sect. 4.4.1 of ECMWF, 2023). Height differences between stations and the ground level of the model, which can be large in mountainous areas, are not managed by the screening but rather by the observation operator described in Sect. 2.2.1.**

- 35 *192-194 'The allocated part of the R matrix for PWSs ... the prescribed observation errors.' Perhaps just 'the same' (instead of 'the prescribed observation errors') if I understood correctly. It might be better to give PWSs larger errors?*

> We have replaced "the prescribed observation errors" by "the same". The largest estimated σ_o for PWSs given by Desroziers diagnostic equals $19.7 \text{ m}^2 \text{ s}^{-2}$ in 3DEnVarP experiment (Table 3) which is much lower than the prescribed one which equals $8g = 78.5 \text{ m}^2 \text{ s}^{-2}$. It suggests that the prescribed σ_o is maybe still overestimated. However, it is true that it might be better to give PWSs larger σ_o than SWSs: this has not been tested. A sentence has been added L195: [The effect of different \$\sigma_o\$ between PWS and SWS observations could be investigated in a sensitivity study.](#)

209,210 'the spatial correlation of observations covariance error' - 'the spatial correlation of observation error'

> We have corrected it.

237 'less than 150 m from higher to lower point' - 'less than 150 m from lowest to highest point'

> We have corrected it.

45 315,316 'The large increase in OmA geopotential mean when PWS observations are assimilated could be explained by the PWS bias correction method, which uses OmB and not OmA statistics for it.' I suspect that using OmA for the bias estimate wouldn't help much - it is more about the relative numbers (and weight) of the two subsets (Eyre, 2016).

We have modified L315–316: The large increase in OmA geopotential mean when PWS observations are assimilated could be explained by the PWS bias correction method, which uses OmB ~~and not OmA statistics for it:~~ statistics, and thus contains model or other observation biases (as SWS ones). As 129 times more PWS observations than SWS observations are assimilated, with the same prescribed observation error, the 3DVar long range PWS increments overwhelm the SWS ones, which questions the relative number of observations in each subset and its impact in different analysis methods.

55 327 'some limits' - 'some limitations'

> We have corrected it.

345 'partly compensates for the significant degradation associated with the transition from a 3DEnVar system to the 3DVar.' should this be 'to a 3DEnVar system from the 3DVar'?

60 Is part of the issue that the 3DVar fields are smoother than the 3DEnVar fields? (Linked to discussion about finer localisation at line 295?).

It is hard work keeping track of the discussion (not helped by the names just differing by 'En') if it is possible to simplify parts of section 4 while still making the main points that would be good.

> We have corrected the inversion between "from" and "to". In fact, the degradation is due to the change of the B matrix from the 3DVar to the 3DEnVar DA and could be due to the finer localization carried out within the 3DEnVar DA scheme, without changing the prescribed observation errors (L295).

We have simplified this section by removing:

- a sentence regarding OmA of 3DVar and 3DVarP (L299): ~~(the OmA geopotential mean for SWSs increases from 4.7 to $11.9 \text{ m}^2 \text{ s}^{-2}$, while the geopotential standard deviation OmA for SWSs decreases by 4%. Similar results are found when observations are compared to the background.~~
- 70 – redundant explanation (L303): ~~, i.e. the OmA geopotential mean (resp. standard deviation) for SWSs is systematically increased (resp. decreased).~~
- a sentence regarding OmA of 3DEnVar and 3DEnVarP: ~~the OmA geopotential mean for SWSs decreases from 12.8 to $12.2 \text{ m}^2 \text{ s}^{-2}$, while the geopotential standard deviation OmA for SWSs decreases by 53%. Similar trends are found when observations are compared to the background: .~~

75 – a few repetitions to lighten the style.

530 'the 3DEnVar was found to create local scale surface pressure increments ...' mention Appendix A and length scales

> We have added (L530): [...] the 3DEnVar was found to create **reduced length ~~loea~~** scale surface pressure increments at the location where the PWS network observed the anomalies. **This reduction of length scale from 200 km in 3DVar to 40 km in**
80 **3DEnVar for a single observation is illustrated in Appendix A .**

References

ECMWF, *IFS Documentation CY48R1 - Part I: Observations*, chap. 1, pp. 1–88, 1, ECMWF, <https://doi.org/10.21957/0f360ba4ca>, 2023.