

Referee2

We thank Reviewer 2 for his/her comments which helped to improve, we hope, the quality of the manuscript. Reviewer 2's comments are in bold font, our answers are written with normal font.

This study is interesting but additional work is needed to improve the quality of the present manuscript to be considered in this journal. Main concerns and some suggestions are listed below. Taking into consideration these comments, I recommend some minor modifications before it can be accepted for publication in the Geoscientific Model Development journal.

General comments:

As it is state above, this study clearly shows the benefits of the second re-analysis in comparison with the first re-analysis and the real-time version of the AROME-WMED model. However, it is not explained which factors (i.e., topography, background error covariance matrix, type of observations assimilated or number of observations assimilated) have played a key role in the improvement of the second re-analysis. With the main objective of improving the quality of the manuscript, a more detailed discussion about the main reasons of these benefits should be addressed performing some numerical sensitivity experiments. For instance, if the second re-analysis used the same topography (GTOPO30) and assimilates the same type and number of observations than the first re-analysis, would the results be very different from the obtained originally? In this example, the differences obtained could be attributable to the effect of the background error covariance matrix.

The second reanalysis was built in two steps. The first step has consisted in changing the AROME code version and the background error covariance statistics. Then many experiments were carried out in parallel to add the observations. It took a long time to run the experiments over a more or less long period.

The benefits of the second re-analysis come from many components. Preliminary studies with an experiment with no addition of new observations have shown that the reduction in the bias of the temperature at 2 m comes from the new orography. The conclusion section has been extended with a figure (see below) and a discussion to highlight the results o REANA2.

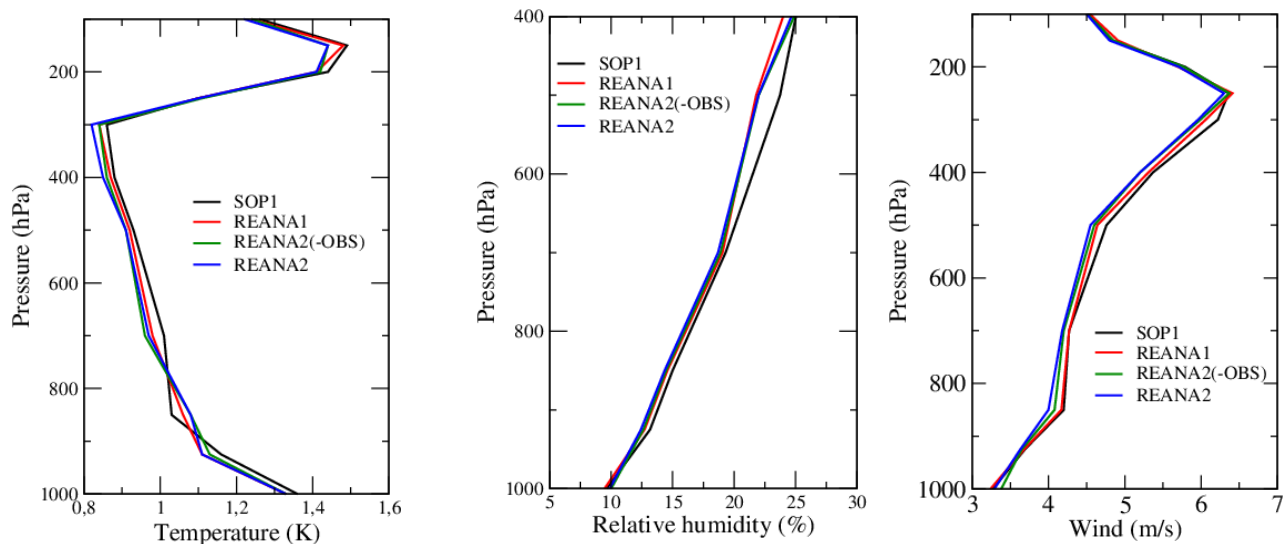


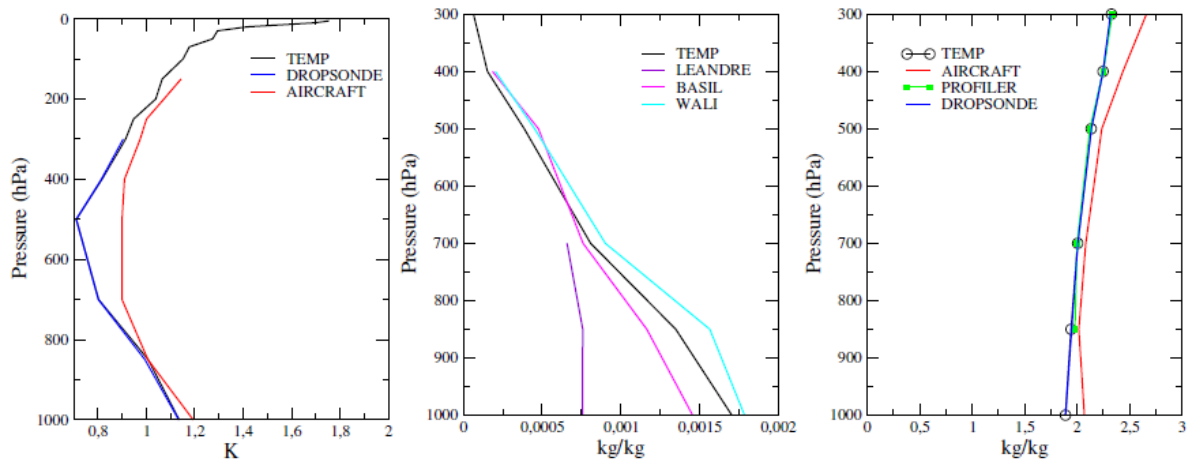
Fig 22 36-h forecast Root Mean Square errors with respect to radiosondes for temperature, humidity and wind.

Preliminary studies with data assimilation experiments with only the version code change including the new backgrounds statistics have shown that the gain in forecast score brought by REANA2 is due to the new observations assimilated and the new code version. Figure 22 illustrates this fact for the 36-h forecast range. A small reduction of the root mean square error is obtained with the assimilation of new observations in temperature and for the wind in the troposphere. The improvement brought by the observations is less clear for the humidity. Concerning the 24-h accumulated precipitation, REANA2 improves small thresholds (0.5, 1 mm/24h) compared to the preliminary experiment, REANA1 and SOP1. It is clear that the 2-m temperature and humidity forecast bias improvement is related to the orography change. The improvement found in the REANA2 fields is therefore the result of all the changes made compared to REANA1 and SOP1. »

A second paper (companion paper) is underway to show the benefit brought by some observation data sets and a reference to this paper is made in the conclusion.

Regarding the implementation of the 3DVar data assimilation technique, no information about the observational errors assigned to the different kind of data assimilated is provided along the entire manuscript. Taking into account the relevant role of this parameters in the effectiveness of the data assimilation algorithm, I strongly suggest the authors to add this information.

We now provide a figure of observation errors assigned to the different datasets and a comment in the paper.



The associated observation errors were deduced from the monitoring of standard deviation of differences between background simulations and observations and they are displayed in Figure 5. Some differences are observed on the plot for lidar data. The observation error for Leandre II data are smaller than the other ones and WALI assigned observation error is slightly larger than BASIL and TEMP ones. Concerning temperature and wind, the assigned observation errors are the same for dropsondes, radiosondes and profilers ; the aircraft data errors are larger.

Minor comments:

The following are some suggestions that could help to improve the quality of the manuscript:

Introduction Section:

1) Page 3 (line 3): “the AROME-WMED re-analyses and the real-time versions The different. . .” → “the AROME-WMED re-analyses and the real-time versions. The different. . .” The point at the end of the sentence was added.

2) Page 3 (line 6): “Intensive Observation Period (IOP) 8” “Intensive Observation Period (IOP8)” The change was made

3) Page 3 (Table 1): Remove open parenthesis “ (” appeared in the REANA1 box. This open parenthesis should be located in the REANA2 box: “(from 17 to 31 October 2012)”. Also, the caption is located very close to the table. Add some additional vertical space between them.

The modifications were made

Description AROME-WMED Model Section:

4) Page 3 (line 21): “The model grid includes a 960x640 point matrix. . .” “The horizontal model grid includes a 960x640 point matrix. . .” « Horizontal » was included between the and model.

5) Page 4 (Figure 1): Add label to the left panel colorbar. In addition, add some extra horizontal white space between panels, they are quite close. The suggested modification were done Figure 1.

6) Page 4 (line 9): Add space after the second 06 UTC: “period 06 UTC-06UTC on the following day” “period 06 UTC-06 UTC on the following day” Done

7) Page 4 (line 12): It is stated that an assimilation window of +/- 1h30 is used. Is this assimilation window used indistinctly for all types of observations? Observations with high temporal resolution, such as radar observations, should not use this large assimilation window. Could the authors provide detailed information of how they apply this assimilation window? The reviewer is right, this assimilation window is applied differently with respect to the observation type. For non frequent observations at the same location, all observations included in this time range are considered. However for frequent

observation types such as radars or radiances from geostationary satellites, observations closest to the analysis time are retained within the (-1h30;+1h30) time range for the assimilation. These details were added in the text : « For non frequent observations at the same location, all observations included in this time range are considered. However for frequent observation types such as radars or radiances from geostationary satellites, observations closest to the analysis time are kept within the time range (-1h30;+1h30) in the assimilation. »

8) Page 4 (line13): “analysed parameters are temperature,. . .” “analysed variables?? are temperature,. . .” Parameters changed into variables.

9) Page 5 (Figure 2): Add a), b), c) and d) labels to panels. Done

10) Page 6 (Figure 3): Same that in Figure 2. Done

11) Page 7 (line 13): “horizontal correlation length-scales are slightly longer”. Do the authors refer to the horizontal correlation scales from REANA2? Please improve this sentence. The sentence was rewritten : « horizontal correlations length-scales are slightly longer in REANA2 than in REANA1 and SOP1 which allows each observation to modify the analysis over a more horizontally extended area. »

Assimilated Data Section:

12) Page 8 (Table 2): The caption is located very close to the table. Add some additional vertical space between them. Done

13) Page 9 (line 9): igher higher. Corrected

Assimilation Results Section:

14) Page 20 (line 14): cumulated accumulated Change made.

15) Page 20 (Figure 15): Add labels to figure colorbars IOP8 Qualitative Evaluation Section: Done

16)Section title: IOP8 Qualitative evaluation IOP8 qualitative evaluation Modified.

17) Page 22 (line 12): Gulf ol Lion Gulf of Lion Done

18) Page 23 (lines 10-11): Regarding ETS verification score obtained from the daily accumulated precipitation amounts exceeding 50 mm/day, it is stated that ETS scores are better for the 24-48 hour forecast range than for the 00-24 hour forecast period. Could the authors provide some explanation of this result? The fact that precipitation forecasted at longer rangers are better than those predicted at shorter range suggests that there could be a spin-up effect in the very short forecast ranges that degrades the forecast during the first hours of the forecast. This explanation was added in the text : « This degradation of the short range forecast could originate from a spin-up effect present in the very short ranges of the forecast that degrades the predicted precipitation during the first hours of the forecast. »