

## 2<sup>nd</sup> Review of “Data assimilation impact studies with the AROME WMED reanalysis of the HyMeX SOP1”

### General comments

The quality of the paper, as well as the clarity in the presentation of results have substantially improved. All of the comments and questions raised have been well answered, although some of them the corresponding modifications were not included in the text.

There are still minor corrections to be included before publication.

### Specific comments

Figure 2 – In the answers to the reviewers it is mentioned that Figure 2 is suppressed from the manuscript since the authors agreed that it adds no relevant physical information. However, the figure and references to it are still present in the manuscript.

L226-L227 – The loss of skill in IWV representation after 12 h needs further explanation. Rephrase to “... correspond to the time of the early stage of convection, which is less easy to predict and introduces inhomogeneities in the water vapour distribution due to precipitation processes (condensation, evaporation, cold pool formation, etc.).”

L243-247 – The introduction to the SEVIRI results is missing and the paragraph seems to be disconnected from the context of the section. Please introduce the paragraph properly indicating that additional experiments were performed even though the results are not shown.

The nomenclature is still confusing in some parts of the paper since, even if the different experiments and validation procedure are well defined in Sections 2.4 and 2.5, not always the nomenclature is respected. For example, in Section 3.1, often “analysis” is written, instead of AN, which can be confusing. Additionally, every time that a confusion between the AN and FG simulations is possible, a suffix to the experiment should be included as EXPERIMENT-FG and EXPERIMENT-AN., For example NOGNSS-FG or NOGNSS-AN. This occurs continuously throughout the text, please correct.

In Figures 10, 11, 13, 15 and 16 add a label indicating the forecast range period (6 to 30h and 30 to 54h) to aid the comprehension of the figures.

In Figure 12 labels indicating that the left panel corresponds to FG and the right to AN are needed to aid the differentiating of the graphs.

In Figures 14, 15 and 16 a label indicating the forecast range (3h) is needed.

The paragraph between Lines 348 and 354 needs more references to existing literature, otherwise the statements are not supported. There have been several other publications for this case study.

Several indications from the last review have not been corrected. Even if in the answers to the reviewers the authors agreed on changing them, none of the following corrections were considered:

- L241 – Change lower panel for right panel.
- Section 3.3 – The explanation about the biases for high precipitation values in Figure 7 is missing. The answers given by the authors were “The loss of skill for OPERGNSS simulation for larger daily precipitation from the 8 3-h forecast is surely due to the lower number of occurrences for heavier precipitations. “. Still this information was not included in the new version of the manuscript.
- IWC was not replaced for IWV
- Iberic Peninsula was not corrected for Iberian Peninsula
- Figure 2 still is in the manuscript.

Conclusions – The relevant messages are somewhat hidden due to some confusing sentences that should be corrected:

L366-L371 – Change for “Two reanalyses were produced after the HyMeX autumn campaign for the first SOP. The first one was carried out after the field campaign to provide reanalyses simulations of the period enjoying an updated AROME-WMED version. The second one, performed a few years after, was done to improve the quality of the first reanalyses, assimilating as many data as possible from the experimental field campaign (i.e. lidar and dropsonde humidity profiles) or from reprocessed data (such as GNSS-ZTD, wind profiles, high-vertical resolution radiosondes and Spanish doppler radars) using the latest AROME version.”

L380-L382 – “... which includes all data sets. In total, the amount of denied data ranged between 0.15 % and 1.86 % of the total number of observations, depending on the OSE and the impact was thus expected to be small.

Our study finds a small positive impact...”

L385-L386 – The explanation of the reprocessed GNSS data is not clear. This information has to do with the OSEs NOGNSS and OPERGNSS but here in the conclusion it is not clear. Please review.

L388-L289 – The information about the validation against RASTA is not clear. Please rephrase. Two are the problems in this sentence. The first is that it is stated that “no impact from Lidar data was found”, but then it is said that “except when comparing to RASTA”. The second problem is that the use of acronyms at this point should be avoided to aid a quick comprehension of the conclusions. It would be better writing “independent airborne radar observations” instead of RASTA.

## Technical corrections

Abstract (L06-07) – Needs rephrasing “...Which are important to better describe the humidity entering mesoscale convective systems, were assimilated”.

L56-L58 – It is important to mind the scope of the paper explaining that that the four observation systems evaluated convey information either on the moisture distribution or on wind circulation. Hence, effectively it is an assimilation aiming at correcting the moisture flux for the SOP1 period. To express this condition more clearly rephrase for “These observation data sets, assimilated in the AROME-WMED reanalysis of SOP1 provided information on the atmospheric humidity distribution and the wind circulation, hence describing the moisture flux of the low-level flow.”

L70-L71 – For clarity rephrase to “These experiments consist of removing one observation data set to compare its forecast quality with the reanalysis simulations, where all observations are assimilated”.

Figure 1 – For readers, focusing only on figures, change “LEANDRE” in legend for “LEANDRE (lidar)”. Like this at a glimpse, the reader knows what observation type is LEANDRE. For readers unfamiliar with the observations from HyMeX.

L112-L113 – Correct typo. Parenthesis within parenthesis.

L125 – Rephrase “were assimilated in AROME-WMED (see Fig. 1)”.

L135 – Correct typo. Brackets within brackets.

L219 – “Comparison to the Integrated Water Vapour”.

L222 – “the RMSE of the differences (Fig.3, right panel).

L227 – “... in data assimilation (Figure 4).”

L227 – Analysis should be AN, see specific comments.

L228-L229 – “... during the assimilation process, with differences between the OSEs.”.

L231-232”... 3-h later. The lowest differences are obtained with REANA-FG and the largest ones with NOGNSS-FG. OPERGNSS-FG differences are close to REANA...”.

L236-L238 – Rephrase: “... data versus OPER-GNSS appears between 700 and 850 hPa.”

L230-L238 – Add suffixes AN and FG, as in Figure 4 (see specific comments). Adding suffixes helps the reading comprehension.

L239-L240 – Analysis should read AN (see specific comments).

L256-L257 – Starting a new paragraph is not advised since the explanation of this bias corresponds to the problem described before. It should read “... and OPERGNSS (4.8 mm). This bias could be explained...”.

Table 3 – Change order of columns, it should be: Mean ZTD (m) | AN ZTD Correlation | FG ZTD Correlation.

L264 – “It is worth reminding...”.

L289 “... when compared to ...”.

L289 – Correct to “to values averaged”.

L290 – Correct to “itself”.

L294 – “... wind (not shown).”.

L310 – “... differences at 300 hPa (left panel).”.

L324-L325 – Sentence reads odd, reformulate.

L341 – “... the Mediterranean Sea...”.