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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Validating the water vapour content from a reanalysis product and a regional climate model over Europe based on GNSS observations" *by* J. Berckmans et al.

Anonymous Referee #1

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This paper uses a new homogeneously reprocessed dataset of tropospheric delays (EPN Repro2) converted into Integrated water Vapor to evaluate the ability of one regional climate simulation performed with ALARO-0 coupled with SURFEX to simulate IWV. The methodology is first described and then results of comparisons between observations, ALARO and ERA-Interim at different time scales are presented and some interpretations are given. The main issue I have regarding this paper is that it concerns only one variable (except very short and speculative discussion on the link with temperature and precipitation bias) and one simulation and I feel that there is a lack of depth in the interpretation of the results which makes the relevance of this paper for the international community very reduced. Hence I invite the authors to explain

in more detail what the added value of this work is, and in particular, its context and perspectives, and to give an attempt at taking a Âń deep dive Âż in the results. There are a number of speculative conclusions that should not be included in the text. As is, it seems like the principal outcome of this project is to assert that very similar results than Ning et al. (2013) found are obtained (depiste a different model and a new reprocessed dataset), and that the use of a RCM at 20km resolution does not have any added-value compared to the use of ERA-Interim.

More details (major and minor comments) are given below :

1. abstract : 'The model presents a cold and dry bias in summer that feedbacks to a lower evapotranspiration and results in too few water vapour.' => Speculative result : this analysis does not demonstrate the lower evapotranspiration. The correlation between spatial averaged seasonal cycle of temperature, precipitation and IWV does not explain anything.

2. Abstract : 'The spatial variability among the sites is high ' : in terms of what ? bias ? variability ?

3. Abstract : ' and shows a dependence on the altitude of the stations which is strongest in summer and by ALARO-SURFEX. ' what explains the strongest dependence in summer, and in ALARO-SURFEX ?

4. Introduction p2, l 6-20: several references to papers of this ACP special issue and/or which use GNSS observations to evaluate models/reanalyses are missing.

5. Introduction p2, l17 : ' Therefore, some authors suggested to be careful when validating model grid boxes with point observations (Ning et al., 2013). ' => Please explain in more detail what you did to address this point in your methodology. This is not obvious in the paper what is different in your methodology than in their. You can add a short sentence in the introduction following this sentence and include more details in section 2. Specifically, the fact that you compare two different grids (ERA-I at 75km

and ALARO at 20km) with point observations is not addressed in the current version.

6. Introduction : the challenges and motivations of getting a good representation of IWV in a RCM's simulation are not enough explicitely described and explained.

7. Section 2.1 : since ERA-Interim surface pressure and mean temperature are used to convert ZTD to IWV, wouldn't it be more faire to compare ZTD datasets instead of IWV ? This question may be beyond the scope of this study, however I am wondering how it helps ERA-Interim to get better results in the comparison ? Shouldn't be useful to compare Ps and Tm from ERA-I and ALARO with and without remapping of ALARO to ERAI grid ? Can this explain the stronger sensitivity of ALARO to altitude ?

8. Section 2.2, p4 l30 : ' . . . the model topography using in ERA-Interim. . . ' => used.

9. Section 2 : I'm not sure to understand why the authors did not use the same methodology between ERA-Interim and ALARO to extract IWV at the GNSS stations. It seems that the height correction applied differs and it is not clear to me what is extracted at the closest grid point, what is bi-linearly interpolated. Please explain and add some numbers to have a way to compare the bias and standard deviation obtained in section 3 with the uncertainty resulting from these approximations/methodologies.

10. Section 2.4 : criteria iii): 15 days for a month is not very restrictive. How many months of less than 25 days do you have ? could you give an estimate of the impact the number of missing days can have on a monthly mean ? For instance, using ERA-I.

11. Section 2.4, criteria iii) : the data length of the station covers at least 10 years : does it mean that it contains at least 10 years with 12 months, or that there is a time lapse of 10 years between the first and the last measurements ? If the second interpretation is the good one, isn't it necessary to add another criteria with a minimum number of months contained in the time series ?

12. Section 2.4 : for the comparison with ERA-Interim and ALARO, it is not clear if the authors used exactly the same sampling than observations by removing simulated

values when observations are missing or not.

13. Section 3 : there is a problem with the line numbering throuhout this section, so I will not refer to line numbers when possible to avoid misunderstanding

a. P8, section 3.1, just before Fig.2: This sentence ' This is due to the lack of assimilated ground-based observations by ALARO-SURFEX (Ning et al., 2013) ' is speculative : lots of reasons can explain the differences between ALARO and ERA-Interim, not only the assimilation of ground-based observations. Dynamics differ, boundary-layer processes also, impact of vertical resolution, horizontal resolution, correction height methodology, the fact ERA-Interim is used to convert ATD into IWV etc. . ..

b. Figure 3a : it is very difficult to see ERAI and ALARO mean values : why don't you use solid lines also since colors differ ? Also, on Fig.3b, increase the width of the zero line.

c. P 9, Section 3.2, 6th and 7th line of this paragraph : please refer to Fig. 4 also.

d. P11, first paragraph : please indicate to the reader that you are analysing Fig.3b. Two aspects of Fig.3b would really need an attempt at explaining what happens, more than what is done in this paragraph (and because it will affect any attempt to compute a trend of IWV): 1) the break/jump in the ERA-Interim time series, with a seasonality which is larger for the first years of the time series until around 2005, with a drift of the bias between 1996 and 2005; and an increase of the bias between 2004 and 2006, with a reduced seasonality afterwards but another drift between 2006 and 2014 ; 2) the drift of ALARO (please modify your sentence since the bias of ALARO does not decrease in time, this is the absolute value of IWV which decreases increasing the negative bias.). If point 1) is due to a change of data assimilation, you have to check that and explain more precisely. At least, use some references.

e. P11, discussion on the seasonal cycle : At the end of the previous paragraph, the authors say 'The seasonal cycle of ALARO-SURFEX exists for all the years, with a peak of overestimated IWV in spring.' and a few lines later they say ' ALAROSURFEX is relatively good in simulating the IWV in winter, autumn and spring with 0.03 kg m-2 , -0.18 kg m-2 and 0.13 kg m-2 respectively, but significantly underestimates IWV in summer with an average of -0.34 kg m-2 (Fig. 4b).' This seems a bit contradictory.

f. P11 : it could be interesting to compare the bias to the uncertainty due to correction height, conversion to IWV etc. . ..

g. P12 : I don't understand ' a wet bias of 5-38% '

h. P12 : please, justify why you can directly compare E-OBS and ALARO for precipitation. Also, concerning the sampling, did you use the same than for the comparison with GNSS (if you took into account missing values in your comparison between GNSS and ALARO, see my comment #12) ?

i. The link between the seasonal cycles of IWV, T and P shoudl be explained in more details, using references and other figures to justify the interpretations. And I think that you can not consider the averaged domain to explain the processes, you need to consider the spatial variability because of the very different processes involved in the arid southern part of the domain, western, central and scandinave parts. In particular, you explain the reduced IWV in summer by the lower temperature which leads to lower evapotranspiration. Another possible explanation, at least for southern stations, is that in spring more energy is converted into latent than into sensible heat fluxes, leading to a cold and wet bias, and in summer, the soil moisture is lacking due to an overconsumption in spring and consequently more energy is converted into sensible than in latent, decreasing the cold bias, and inducing a lack of moisture to reach the water-holding capacity of the atmosphere, generating a dry bias.

j. The section concerning spatial variability should be put and discussed before section 3.2, and at least before the seasonal cycle.

k. Please try to explain (see comment #3)

l. Section 3.4 : please explain the motivation : why is it important for a model to capture the diurnal cycle of IWV ?

m. Section 3.4, p19, last sentence : once agin, this sentence is very speculative !!

14. Discussion : what do you expect from a simulation at 20km resolution compared to ERA-Interim ? What are the added values of this new dataset ? of this methodology of comparison ? of this simulation etc. . . ? You conclude that at this resolution the feedback between water vapor and other variables could lack of a sufficient representation but at any moment you try to test this representation. What do you expect from an increased resolution ? And how will you check that feedbacks are better represented ? I would suggest to first focus on the reasons why the model is not perfect before trying to use higher resolution simulations that are very expensive in computational time and ressources. You have a lot of aspects that have not been explored in the physics of the model.

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