Referee #2	Response of the authors
I would not have guessed that outcome in numbers Without the evaluation of a representative number of scenes, such conclusions cannot be drawn. But there are other reasons, which in my view make the conclusions even more questionable.	The numbers were tested again and they are correct. Thank you for emphasizing this point. We totally agree that the larger the test dataset, the more reliable the conclusion is. However, please note the following. Within this study, we put the focus on finding and testing a proper data fusion approach for water vapor mapping in the test region Upper Rhine. We are interested in characterizing and understanding the atmospheric conditions in the region. This is also required for the related geodetic and geodynamic studies within the area. This region has special location and topography and might be affected by certain dynamics in the atmosphere. Therefore, we used the data available for the research. The main problem about water vapor mapping, in general, is the limited available data; therefore, we are attempting to provide more information using geodetic methods. From InSAR and GNSS, we could produce 17 maps from 17 available SAR images, corresponding to them only 5 MERIS maps under cloud free weather are available. The WRF data were simulated for 1 year with 5 month spin-up time. At the end, we have only 2 time points were InSAR, GNSS, MERIS, and WRF are all available. In the submitted paper, we presented one example to keep the paper short; however, we added the other example in the revised paper to enable the comparison. Since InSAR+GNSS provide maps over 100 km × 100 km, the reference data have to be available over the entire area, which is provided by MERIS, which data are acquired simultaneous to InSAR. For the evaluation, we need at least one independent source to avoid a correlation in the error, that it is why MERIS was not included in the fusion. Also, the selection of numerical atmospheric models for data fusion was made because we expect that they are getting more attention in current and future research and will continue to be a source of data for atmospheric parameters.

	In the conclusion, we describe the ability of the method to fuse different data sets of different properties and the benefit of data fusion over single data sets and the numbers presented refer the presented example.
1. While the quality of the observation data from remote sensing mainly depends on the applied measurement/estimation method, the quality of the model field depends mainly on the quality of the forecast (here dynamical downscaling). So while the error of the former has in principle no spatial correlation, the error of the latter will by highly correlated in space because it will depend on the quality with which atmospheric flow is predicted. For example a timing problem in the prediction might generate a very accurate field but due to e.g. a delay the patterns would be shifted and lead – when compared point by point - to a very bad quality. The method presented here, however, does not account for this most common error of predicted atmospheric fields. Thus there is a large potential that the WRF field rather tends to worsen the results of merging. Since the WRF field is produced by double nesting in a quite large area (Fig. 2) without data assimilation within, I do expect considerable timing errors.	Yes, we noticed this timing (or synchronization) problem in WRF, this cannot be denied, so we did the following: At the beginning, we compared the WRF data with remote sensing data (from InSAR+GNSS and MERIS), we found that few scenarios show good correlation, particularly if the elevation-dependent water vapor signal is dominant, and other scenarios show low quality. We have to mention here that the comparison is done after subtracting a linear trend from the data since WRF data are most likely biased, particularly in summer. The timing error is beyond the scope of the research, which has the focus on data fusion to better model the atmospheric water vapor, and we used the maps that show minor time errors (We tested the model output at time instants around the required time point.) to test the presented approach. The approach presented in this paper shows that data available from different sources can be used to improve the knowledge about water vapor. For data fusion, we could fuse InSAR+GNSS with WRF and MERIS and any other data, when available. However, we made the fusion without MERIS to have an independent reference data for evaluation. In addition, we wanted to show that numerical atmospheric models can be used to improve the quality of water vapor and for future research the assimilation with remote sensing data could be of great benefit, particularly for local atmospheric simulations.
2. The region, for which the case study is performed, is characterized by strong rather large-scale topography, which is of course dominating the vertically integrated water vapor field (high in the Rhine valley and low over the ridges). This alone leads – by the way – to the nice resemblance of the MERIS and WRF data e.g. in Figure 3. And it will of course	We showed in a now-published paper* that the precipitable water vapor can be subdivided into a larger elevation-dependent component and a smaller component due to turbulent-mixing in the atmosphere. According to weather conditions and topography of the region, the first component may dominate the water vapor map and hide the spatial variations of the

improve the merged product in places, where the InSAR/GNSS observations are not available due to incoherent scatter. The use of topography information in the merger – instead of WRF – would probably lead to even better results, especially when the timing error in the WRF field is large. I assume, that with the topography information added, WRF would not lead to any improvement. The authors need to test this.	turbulent signal. In this case WRF can provide good maps that show spatial correlation with reference data such as MERIS. However, the atmospheric dynamics highly affect the water vapor content and turbulent signals with high spatial variations, which make the atmospheric modeling more challenging. Back to the point of topographic data: topography alone cannot be used within the FRK model. This approach has to use similar input quantities, water vapor in our case; which means that only topographic data cannot be useful. In a previous paper*, we used a model that relates water vapor content to the surface elevation, which we can use to test the reviewer hypothesis; however, this model requires water vapor data, which can be received from GNSS, but GNSS data are already involved and cannot be used again. Other data, for example from radiosondes are not available, but we can think of this point if this research is extended. What we speculate here is that the results cannot be better. Since the elevation-dependent water vapor represents a part of the entire signal, ignoring other signal would, in our opinion, worsen the results, but this remains open until further investigations. * Paper: Alshawaf, F., Hinz, S., Mayer, M., and Meyer, F. J.: ***Constructing accurate maps of atmospheric water vapor by combining interferometric synthetic aperture radar and GNSS observations***, Journal of Geophysical Research: Atmospheres, 120, 1391–1403, 2015a.
3. I hypothesize, that the improvement by adding WRF is solely due to the filling in of WRF data in areas, where InSAR/GNSS fails, namely in the forested and usually elevated regions. Again using topography could lead to the same if not better results.	This hypothesis is explained in point 2 above.
4. Also MERIS comes with an error. I did not find where this error enters the methodology. Also MERIS cannot estimate PWV where there are clouds; the case shown must be a very rare cloudless case.	We described above and within the paper that MERIS cannot provide useful data under cloudy weather conditions; therefore MERIS data were not used for the fusion but for the evaluation. MERIS has uncertainties of about 1.5 mm. Since MERIS is not used in the fusion, we did not talk about the error.

The current text feels like a cut-and-paste from a PhD theses	Thank you for the comment. This work was done within a joint venture, and we do not rely on a copy-paste method.
Why– again – explaining kriging. Better explain the new method and concentrate on the differences to kriging.	We explained very briefly the ordinary kriging (the model and the necessary deramping step) to show the differences to the FRK. For the readers who do not know about kriging, we believe this is important.
Also the way the InSAR/GNSS product is produced needs more explanation, and how often such a product would be available.	Yes, you are right. We put the focus of the paper on the data fusion; otherwise, it will be too long. This topic is described in details in the following papers, which are added to the paper. (Comment#11) Paper: Alshawaf, F., Hinz, S., Mayer, M., and Meyer, F. J.: ***Constructing accurate maps of atmospheric water vapor by combining interferometric synthetic aperture radar and GNSS observations***, Journal of Geophysical Research: Atmospheres, 120, 1391–1403, 2015a. Alshawaf, F., Fuhrmann, T., Knopfler, A., Luo, X., Mayer, M., Hinz, S., and Heck, B.: ***Accurate Estimation of Atmospheric Water Vapor Using GNSS Observations and Surface Meteorological Data***, Geoscience and Remote Sensing, IEEE Transactions on, 53, 3764–3771, 2015b.
Further remarks	
Abstract: avoid the terms “accurate” without putting numbers to it. I question that the PWV maps have accuracies of submillimeters. As written above, the second to last sentence/conclusion cannot be drawn based on the results. 2. 364/21: What do you mean with volumetric concentration? Check the value. 3. 364/23: Neutrosphere is strange. Better use troposphere, where the water vapor you measure really is.	This is modified (see the Abstract). We propose to reformulate the sentence to: “Although the ratio of water vapor partial to total pressure is typically below 4%, it is an important constituent in many respects.” The value of 4% was again checked. (Comment#1) In the geodetic community, we subdivide the atmosphere according to the presence of charged particles into the ionosphere and the neutral atmosphere (neutrosphere), and to be consistent, so we prefer to use neutrosphere.

4. 364/25: There is no "precise" prediction of clouds and precipitation.	Text is modified
5. 365/20: What is meant with the atmospheric phase?	Text is modified. (Comment#2)
6. 366/11: You have to define the scales (lengths) here.	With spatial wavelength of about greater than 20 km (text is added)
7. 366/16ff: The meaning of this sentence is unclear. Parameterizations change the model outcome with variable effect on the quality depending on the situation/climate. Better remove it.	We propose the following change for the respective text section: "This, in addition to the configuration of the model domains, can significantly impact the simulation output (Gonget al. 2010, Fersch & Kunstmann 2014) as well as the model intrinsic water balance (Fersch et al. 2012, Fersch & Kunstmann 2014). Therefore, the setup of the local area model is crucial, and it has to be proper for the study region and the research objectives." (Comment#4)
8. 366/23: What do you mean with spectrally?	Acquired by imaging sensors of different frequency bands (no change in text).
9. Since the merging of 2 data sets is proposed for a better analysis of vertically integrated water vapor fields, the availability of the InSAR/GNSS should be discussed in the introduction in view of water vapor variability in time.	Yes, text is added in the introduction. (Comment#3)
10. 373/19: What exactly is the roughness of a spatial variation?	We meant the variability from smooth to high fluctuations according to spatial wavelength. Text is modified.
11. Remove the WRF wet delay from Fig. 9. It is not discussed in the text and not described in the heading.	We compare the interpolated maps using OK and FRK to the WRF map. This is mentioned in the text. (Comment#9)
12. Use the same gridding/area in Figs 10. and	A box is added to the input data in Fig.10 that indicates the prediction area. We think this a better way to display.
11 and put more numbers at the water vapor color bar.	Done