

Second Review Peng et al. 2018
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Recommendation: Major Revisions

General Comments.

The English has improved substantially over the last version, but there are still many grammar errors and awkward sentences. More importantly, the authors still need to address some of the critique of their analysis I brought up in my first review. Firstly, the error reduction (if we can even call it that) due to their model is very small. You need to address all of the sources of errors associated with PWV, including, very importantly, the calculation of ZHD. Even if you cannot quantify directly these errors, you need to recognize that they exist and that they may be very large compared to your improvement in the T_m model.

These tiny error reductions of 2mm to 1mm in PWV could very easily be attributed to errors in ERA-Interim or radiosonde temperature and humidity profiles. And because there is no standard baseline PWV value against which to judge this error reduction for a given locale, it is difficult to draw conclusions about the improvement due to the author's time-varying global gridded $T_s - T_m$ model.

The authors have fastidiously avoided mentioning one of the largest sources of errors -- errors in P_s in the calculation of ZHD. An error of 1mb in the surface pressure in their equation (1) is 2.5 times as large as an error of 1 degree C in temperature using the Bevis $T_s - T_m$ equation, $T_m = 0.72 T_s + 70.2$. Why is this problematic? Let's first assume that local barometers measure pressure perfectly, which of course isn't true, but not much we can do about this. Now, more importantly, the inherent uncertainties in surface pressure measurements in ERA-Interim interpolated to a local site can lead to the errors I mention above (2.5 times as large as surface temperature errors). Of equal importance, error in antenna height relative to the height of the pressure measurement can introduce large errors. Snajdrova et al. (2005) found that 10 m of height difference approximately causes a difference of 3 mm in the ZHD. Now imagine GPS PWV calculated with an interpolated surface pressure from ERA-Interim over very complex terrain where errors could easily be greater than 100m.

Likewise, as I insisted in my previous review. The authors have not even mentioned the fact that ZHD doesn't take into account existing water vapor in the atmospheric column. This error is small, but in the deep tropics the mass of water vapor can be near 4% of the total column mass.

Considering all of these sources of errors I mention about, the small reduction (assumed) in error due to your model is not particularly notable considering that substantial errors in surface pressure can be associated with reanalysis or radiosonde data. Finally, the authors need to be more critical of ERA-Interim. I have worked with these data and seen how poor they are over regions of complex terrain, for example, in the North American Monsoon region.

Minor Comments

Line 39 Write "GPS observations require some kinds of meteorological elements to estimate PWV ..."

Line 43 Write "are the latitude"

As I noted in my previous review, you need to clarify what ZHD is. And the fact that it ignores water vapor in its calculation. This is a small error (maybe more important ~4% of total mass in equatorial regions), but you need to mention it.

Line 67. “these models independent of real meteorological observations.” As I mentioned in my previous review, this is not typically true. NWP models are most often initialized and constrained with some form of real-world observations. So they are not independent in this sense.

Lin 71 Write “weather prediction.”

Line 83 “without high-precision specific $T_s - T_m$ equations.” Clarify what you mean here.

Line 84. Write “Significant differences exist between oceanic and terrestrial atmospheric properties, especially near the surface and within the boundary layer, in general.”

Line 89-90 “However, the $T_s - T_m$ relationship has time variations and can produce residuals in the static T_m estimations (Yao et al., 2014a). Such residuals are not fixed in Lan’s model.”

It is not real clear what you are trying say here. Lan’s model (Lan et al. 2016) is static and there for doesn’t include time variation in $T_s - T_m$ as does Yao et al. (2014) estimation. This is what I think you want to say.

Line 94-95 Write “...smoothing of the data, then assess their precision,...”

Line 110 Write “are from the earth’s surface to the top of the troposphere”

Line 120 Write “...observations must be available,...”

Line 125. As I stated in my previous review, you need to say something about the quality of ERA-Interim, particularly for regions with sparse observational data. Humidity can be very poor in ERA-Interim and your integral depends on it.

See for example the recent work of Itterly et al. 2018

Sensitivity of the Amazonian Convective Diurnal Cycle to Its Environment in Observations and Reanalysis

<https://doi.org/10.1029/2018JD029251>

Line 129 Write “ ...should be integrated through the entire atmospheric column

Line 146. You should state here that these two are not independent even though you explore it later. Radiosondes are assimilated into ERA-Interim, so you need to state this explicitly.

Line 158 “Unreliable regression analysis results may be derived by both the T s and T m with small variations.” What are you saying here?

Line 159 “is quietly obscure”. This sounds very poetic, but I am not sure what you mean.

Line 190 “Attributed to no spatial or temporal smoothing of any data in our study, the precision and resolution of our static model, with no RMSE larger than 4.5 K, is clearly better than previous studies (Lan et al., 2016).” Rewrite this sentence, it is not very clear.

Figure 5 is not very attractive. Neither is Figure 4. The small numbers are a bit of a distraction.

Line 338 and throughout. PWVs should just be written PWV

Line 349 Some relative RMSEs were remarkably reduced. For example, at the ALIC site which is located in Australia with mean PWV of approximately 23 mm, the relative RMSE dropped from 1.97% of PWV BTm to 1.10% of PWV VTm .

THIS IS NOT REMARKABLE!

Line 353. “It is attributed to the wetter atmosphere in summer than in the winter.”
Why would the error be larger just because the atmosphere is wetter? You need to give a physical reason as to why this should be the case.

Line 409 “However, at some special sites, such differences could decrease by more than 30% in wetter conditions” This is a bit misleading, your small error can decrease by 30%.

References

Snajdrova K., Boehm, J., Willis, P., Haas, R., and Schuh, H.:Multi-technique comparison of tropospheric zenith delays derived during the CONT02 campaign, *J. Geod.*, 79, 613–623, doi:10.1007/s00190-005-0010-z, 200

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