Answer to Reviewer #3

We would like to start by thanking you for all the time and effort which you spent reviewing our paper. All your comments, suggestions, and questions were taken into account and the necessary corrections were made.

Brief Summary of the Manuscript

This manuscript attempts to estimate the IWV around the Israel peninsula by combining ground-based GPS derived IWV with METEOSAT-10 IR surface temperature observations. An empirical relationship between METEOSAT-10 pixels and GPS IWV is derived, in order to exploit the potential of METEOSAT-10 observations to provide a complementary observational data set to ground-based GPS stations. The expected analysis could provide a novel technique to remotely sense from space-based platforms the IWV, not only over land regions but also over oceanic locations.

Major Comments:

1) The manuscript lacks motivation/objectivity: The authors need to establish the motivation for and objectives of this study. The use of ground-based GPS receivers to retrieve IWV is a well-established technique, and therefore its application to the Israel peninsula does not provide a significant science contribution. What is unique in this analysis? And why this analysis needs to be done? This is one of the first such studies for Israeli area. The article is not only about investigation of GPS derived WV but it is combined with remote sensing results. Besides the estimation of WV using GPS derived ZWD we also tried to estimate METEOSAT derived WV. This analysis needs to be done because it allows estimating WV using only remote sensing data. This way is fast enough and it doesn't require using different software like GIPSY-OASIS or GAMIT-GLOBK. One more advantage is possibility to apply WV estimation in near real time mode; it is as fast as we can obtain the METEOSAT-10 data.

2) The methodology needs explanation: The scientific merit and novelty of this study is the calibration of the METEOSAT-10 satellite observations to infer IWV, which I find quite interesting because it has never been done before. That said, I would like to see a detailed focus/explanation as of how the calibration happens. We have revised and edited the methodology part adding more detailed expiations regarding the calibration procedure.

3) Line 132: The elevation cut-off angle is routinely set to 10^{o}. Why did the authors decide to use a cut-off angle of 7^{o}? How would their results change if higher elevation angle were used? Does the elevation angle affect the sampling rate of the ground-based GPS receivers? What is the quality of the surface temperature observations of the METEOSAT-10 satellite?

Elevation cut-off is set to 7^{o} based on suggested recipes for using GIPSY strategy. We refer the reviewer to [*Bar-Sever et al.*, 1998]. Mainly it's due to the fact that the effect

of horizontal gradients diminishes quickly as the elevation angle increase. Therefore to sense the gradients it might be necessary to include low elevation angle observations. At the same time, reducing the elevation angle cutoff too much may result in increased errors from multipath and troposphere mapping function. Elevation angle cutoff of 7^o is considered as a reasonable compromise. The technique which allows to translate METEOSAT-10 images to absolute temperature is described in documents related to METEOSAT-10, e.g. in PDF_TEN_05105_MSG_IMG_DATA.pdf [*Muller*, 2010]. Briefly, we obtain pixel luminosity and due to the formulas in the document, mentioned before, translate it into the temperature. The comparison of temperature from meteorological stations and METEOSAT is shown at the article but it is also shown that even in the case of big differences in temperatures, we don't get a big influence on the final IWV estimations.

4) Line 200: The water vapor distribution is quite variable over horizontal scales. Why do the authors assume a uniform distribution of IWV? This seems to be a critical component of the calibration process. How does non-uniformity impact the derivation of Equations (3–8)? What is the sensitivity of equation (9) to the choice of values in equations (3–7)? We realize that WV is quite variable over horizontal scales, but we assumed that the descending air in the subsidence inversion is rather dry and the absorption of radiation is low and the IWV is distributed uniformly around the Earth only for the purpose of projecting correctly the slant to vertical absorption). In our opinion, it is better than providing no normalization at all. Equation (9) doesn't depend on parameters of previous equations; it is used only for taking earth relief into account. This equation represents the vertical distribution of WV.

5) Figure 4: The linear regression between the METEOSAT-10 and IMS? The blue line fit does not seem optimal. I notice that the slope of the fit should be smaller with a y-intercept around ~ 297.5 K. We have changed this figure and added more data.

6) Figure 8: What are the 1-sigma uncertainty errors of the fit? 0.49 kg/m^2 and mean value is 0.27 kg/m^2.

7) The statistical sampling is rather small and does not guarantee statistical significance. We added more data and we suppose that now it is enough for statistical significance.

8) How does METEOSAT-10 IWV look like under cloudy conditions? In comparison with GPS IWV it depends on mutual location of the station and clouds. A more detailed description is explained in the revised manuscript.

9) What does the surface temperature error of 2^o introduce to IWV? It depends on zenith wet delay and temperature range. It might be innaccuracy from 0.5 to 1.5 kg/m.

Minor comments

a) **Line 26:** IWV is mostly due the boundary layer water vapor. It does not tell us anything about dynamical processes in the upper troposphere. I consider revising this statement, or remove it complete it because it appears to be out of context. Corrections were made in the revised manuscript.

b) **Line 319:** The statement about the upper air conditions is out of context. Corrections were made in the revised manuscript.

c) **Line 31:** Should read: "network". Corrections were made in the revised manuscript.

d) **Line 53:** Should read: "temperature". Corrections were made in the revised manuscript.

e) **Line 59:** Should read: " manifests". Corrections were made in the revised manuscript.

f) **Line 78:** Should read: "characterize". Corrections were made in the revised manuscript.

g) **Line 35:** Should read: "...bent..."

h) Mention that radiosondes are limited over land regions. ". Corrections were made in the revised manuscript.

i) Mention that radiosondes are radiation-contaminated in the upper troposphere. Corrections were made in the revised manuscript.

j) **Line 84:** Should read: "signals", "therefore". Corrections were made in the revised manuscript.

k) **Line 85:** Should read: "are slowed down". We choose to leave it as is.

l) **Line 96:** Should read: "continuously". Corrections were made in the revised manuscript.

m) **Line 96-97:** The sentence is incomplete. There is something missing. Please, re-write. Corrections were made in the revised manuscript.

n) **Line 153:** Should read: "represents". Also, define what you mean by "nearest". Corrections were made in the revised manuscript.

o) **Lines 154-156:** Current RO missions do not use closed loop tracking. Please, re-write this section.

p) **Line 187:** Should read “represents”. Corrections were made in the revised manuscript.

q) Define all variables: k, L, l, beta, alpha in the equations. Also, consider re-writing equation (9), because the alphas are inter-mixed. We leave the equation as is. We used these parametrs in order to make equation 3 more shorter.

r) **Line 273:** Should read “techniques”. Corrections were made in the revised manuscript.

s) **Line 293:** Should read “it” Corrections were made in the revised manuscript.
t) **Line 314:** Should read “needed” Corrections were made in the revised manuscript.

We corrected all these mistakes and inaccuracies.