Atmospheric
Measurement
Techniques

Open Access

Discussions

EGU

Interactive comment on "Precipitable Water Characteristics during the 2013 Colorado Flood using Ground-Based GPS Measurements" *by* Hannah K. Huelsing et al.

Anonymous Referee #3

Received and published: 15 June 2017

General comments for authors

In the manuscript titled "Precipitable Water Characteristics during the 2013 Colorado Flood using Ground-Based GPS Measurements" the authors present some studies about the PW variation during the most severe event of precipitation observed in Colorado State, using the GPS, reanalysis and radiosonde data. The main objective is to examine the characteristics of atmospheric PW during the 2013 Colorado Flood, data with a high spatial and temporal resolution was needed to resolve features within the event. However in my evaluation the present version of the manuscript does not demonstrate the potential benefits offered by GPS data to identify and PWV charac-

C1

teristics associated with severe event of precipitation. Two scientific questions are presented: (1) What were the characteristics of PW surrounding this event? and (2) Where did the moisture for the 2013 event originate? In (1) was not done a analysis of the GPS-PW before, during and after the precipitation event as promised. The analysis of climatological data is centered in a only figure, which the presentation is terrible to see the results. In (2) the transport of humidity is evaluated using the reanalysis products and water vapor anomaly from GPS data. The GPS-PW is a secondary information and some times it is erroneously used to evaluate the humidity flux. The high temporal resolution from PW GPS are mentioned but is not explored to characterize the PW variation during the severe precipitation event. I am not able to see in this manuscript how GPS data provide additional information than the radiosondes and reanalysis products. The most important results were obtained to use the radiosondes (figure 4 and 5) and reanalysis data (figure 8). Besides, this manuscript:
- (a) not presented the used methodology to obtain PW estimates from GPS data, as required by readers of this Special Issue;
- (b) the bibliographic revision is poor, which not mention the previous study about the GPS applied to PW monitoring and severe precipitation;
- (c) The precipitation time series is not presented by suitable way;
- (d) There are many technical corrections and imprecision in the text and presentation of results of this manuscript, which demonstrated lack of attention in the elaboration.
More details about each one these points are presented below in the section "Specific comments for authors". Summarizing I think this manuscript can not be published in the Special Issue: Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate from AMT.

Specific comments for authors

C2

(I) General aspects of the manuscript:

1) The motivation of the paper are not suitable and should be improved. I do not agree that there are not previous work that examine the characteristics of the PW and precipitation, although the number of this works is not expressive, some work should be mentioned and the results most important should be discussed in the introduction. No previous work was discussed. By the way, the number of the works referred in the text is very low. There are several research groups in different parts of the globe involved in this theme.

2) The climate change and relationship with severe precipitation are presented in introduction section out of context and a speculative discourse. This could be discussed in final section referring the other papers for mention the of possible link between these themes.

3) The authors state (lines 160-162): "... better understand the contributions of PW to an extreme precipitation event with the objective to someday apply these results to future research incorporating a wider variety of events." This statement can be the final aim of this research about GPS-PW. However, they are not clear how the GPS data can help in this aim, based on the results presented in this paper. GPS data are not suitable explored.

4) The aim of the work is examine the characteristics of PW during the precipitation event of 2013 and an analysis of the climatological series of PW is used. This analysis,

C3

presented in Fig. 2, is poor and the quality (the size or zoom selected) not make evident the abnormality of this event. In my opinion this climatological study (as organized in this figure) does not help the examine the characteristics of the event. Besides, the PW time series shows that there are many similar values to observed in September of 2013 and severe precipitation was not observed (for example see September of 2011).

5) In this Special Issue, all details about the methods and options selected in the GPS data processing to obtain Zenithal Tropospheric Delay should be presented and discussed, as well as about the conversion in PW estimates. The current version of the manuscript discusses briefly the used methodology to obtain PW and only an paper is referred (Ware et al. 2000). Other more recent works should be used because the methodology employed in the GPS data processing have been improved in the last years. There are many aspects and options that would be taken into consideration to obtain PW, which significantly impact in the quality and behavior of PW time series from GPS data. For example: what kind of products for orbit and clock for satellite was used and what is the sampling of these products? Elevation-Dependent Weighting used for GPS observations was used? Was tropospheric models used for ZWD time evolution constraint as a random walk process? Were tropospheric gradients estimated? If yes what are the constraints of temporal evolution of these two parameters? Several specific works should be referred in this description.

6) The list of GPS stations used in this paper is not suitably presented, which are used in several parts of manuscript (i. e. figures and text) but the GPS stations are not described with more important information presented. For example, the Figure 1 shows the geographic localization of the GPS stations, but they are not mentioned in the text. Line 211: "This region encompasses six SuomiNet stations and two IGS stations (Fig. 1a)". Which stations were used? The figure 1a not present any station. A table with

C4

more relevant information about the list of used GPS stations in this study should be presented in the beginning of the section 2.

(II) Analysis of data and interpretation of results

7) The precipitation time series should be better explored in this study. Although this information is crucial to characterize the GPS-PW variation before, during and after the precipitation severe event, the precipitation values are presented separately from PW values in a last figure of the manuscript (Figure 9). These data are critical for this study and should be better discussed in term of intensity and relationship with PW oscillations. Separating the time series of precipitation and GPS-PW the authors committed a serious mistake, which penalize the analysis of results and hinders to reach the proposed aims. The precipitation time series should be presented in Figs 3, 4 and 5, at least.

8) The Figure 2 shows PW values larger than the observed values in 2013 September (e. g. September of 2011) and it was not observed intense precipitation. This fact should be discussed.

9) Lines 283-294: The description of the results presented by Fig. 3 is very poor, which describe the period where the PW decreases and increase. The precipitation time series in this analysis should be interesting and it would help the analysis of those results.

10) Figure 4, I agree with David Adams that "fully saturated atmosphere, i.e. 100 relative humidity from the surface up to 300 hPa." can not be accepted and this analysis should be completely redone. I don't understand why the GPS-PW values in high temporal resolution are not explored in this analysis, which could be very much rich.

11) In the analysis of results in Section 3.2 the authors try to demonstrate the abnormality of PW values during September of 2013, when precipitation severe event was observed. I can not understand the reasons why in this analysis monthly-averaged values are used (Figure 5). The reported values of the monthly-averaged for September 2013 is the largest, which is the expected result above of normal. However, this analysis using monthly-averaged is not able to characterize the PW oscillation before, during and after the severe precipitation, as is proposed in the introduction section.

12) In section 3, GPS-PW in high temporal resolution are not explored before, during and after the severe event of precipitation, consequently the authors did not demonstrate the additional benefits obtained with GPS data than the usage of the other techniques of water vapor measurement. The same study can be carried out using the radiosonde data, which not justify the publication of this manuscript in this Spacial Edition about GNSS-PW estimates

13) In the analysis of water vapor transport, a bibliographic revision of previous work is done and results are reported. A similar analysis is done in the current version of the manuscript, using reanalysis data and water vapor anomaly from SuomiNet. The reported results not make evidence about the contribution of GPS data to corroborate with the results reported by these previous works.

14) In the analysis of water vapor transport (Figure 8) the selection of the time steps are aleatory or opportune without objective justification for the definition of these time steps. Why are these time steps used in different hours of the day? A figure with GPS-PW and precipitation (unacceptable lack in this study) would be used to justify this choice.

15) In the analysis of results the anomaly fields of water vapor from SuomiNet PW data (Figure 8) are used to indicate more drought or wetter atmospheric condition. It is a mistake because negative anomaly can not indicate a drier condition, but lower values than the climatological average. This is done in the line 391 and other parts of this manuscript

(III)Technical corrections and imprecision

16) Line 211: The Fig1.a is mentioned when the correct should be Fig.1b, which it is the correct plot that shows the GPS stations.

17) Lines 294-297: This comment about the humidity transport should be in the final of the subsection 3.2, before section 4.

18) Line 313: 2013 PW monthly averages were consistently lower than climatology until June and not July. In July the PW monthly averages were larger than climatology. .

19) Line 560: The NISU station is mentioned in the caption of the Figure 1, but I can not see this station in the plot of this figure. This station is used in others parts of the manuscript but: which are the information of this station? See item 6 above.

20) Line 490: The number of previous work referred in this manuscript is very low. There are many important papers about this theme that should be included in this study. No paper from AMT and EGU were mentioned here.

21) Line 550: The rain values presented in the Table 1 are in inches, and should be converted by mm, because the PW is presented in mm and the comparison is more direct when same unit are used.

22) Line 556: The Fig. 1a shows the preliminary precipitation accumulation values for Colorado, but this field is not mentioned in the manuscript. The plot 1.b of this figure is terrible to see the geographic localization of the GPS stations and coordinates are not expressed in this map.

23) Line 563: The Sept not should be in GPS station legend of the Figure 2.

24) Line 563: The figure 2 is not suitable for analysis of the results about the PW oscillation during the 2013 September and to compare with other Septembers. This figure should be significantly improved. The results are confused and they turn an

arduous task to affirm some conclusion.

25) Lines 573-587: The precipitation data should be in Figures 3, 4 and 5.

26) Line 574: The term "all times are in UTC" are not correct because the time in the figure is in Days. The same for the figures 3 4 and 9.

27) Line 586: In the figure 5 it is mentioned the 95th (dashed red line) and 99th (dotted red line) percentiles for 10 years and these lines are not showed.

C9