

Review of “The use of ground-based GNSS for atmospheric water vapour variation study in Papua New Guinea and its response to ENSO events.”

Response to the reviewer

Dear reviewer,

Thank you very much for your time in reviewing this manuscript. Your analysis and in-depth critical comments, suggestions and recommendations on this paper are well acknowledged and very much appreciated.

- Paragraph 3: The comments in the third and fourth paragraphs regarding the outdated literature review is well noted. It would be more appropriate for the manuscript to add special issues and articles submitted to ACP with a more updated GNSS PWV introduction as per reference tips and suggestions by the reviewer, and should elaborate more on newly evolved NWP models. Adding on, yes indeed the climatic description of the study area is referenced to old references as there is literally a huge void concerning meteorological and weather studies around the Papua New Guinean region in the 21st century, which is also one of the aims of this paper: by attempting to provide some information about the climatic change over this region through atmospheric water vapour studies.
- Paragraph 4: The reviewer is correct. Due to unfortunate circumstances during the start of this study, the authors we were forced to used ERA-Interim. However, the advantageous aspect of ERA5 that the reviewer raised on investigation the diurnal variability of PWV is noted and should be looked into. Therefore, this manuscript will be revised to apply ERA5.
- Paragraph 6: The suggestions and expected interpretation of presented results of radiosonde measurements is well acknowledged. A more careful investigation into the radiosonde types used at Momote station during the active period and moist bias shown after 2006 onwards will be investigated again with proper discussion. Also, the nil bias between GNSS and radiosonde will have to be elaborated too.
- Paragraph 7: Section 3.1, the Tm error analysis was included in the paper to validate the reliability of using Tm derived from ERA Interim by comparing with radiosonde at one of the locations, however it did not quantify the impact it has on PWV. Therefore, this section will to be removed.

On that note, the three GPS stations are not collocated with meteorological sensors or neighbouring synoptic stations, and therefore reanalysis products of Tm and Ps from ERA-Interim were used which provide the optimal data source for PWV retrieval. These two PWV datasets are considered independent as GNSS data are not assimilated into ERA-Interim, allowing for an independent validation of ERA-Interim. But further discussion on this will have to be elaborated better in the revised manuscript using ERA5 PWV, which will expect correlate to some extent.

- Paragraph 8: Concern and critic for short PWV trends is well noted. PWV trends derived from radiosondes between 7 to 13 years are not reliable nor do they represent PWV variation from a climatic standpoint properly due to gaps in radiosonde PWV data and the large uncertainties in the trend. Although the GPS stations time span are rather short to the required 30 to 40 years to detect significant PWV trends as published by Alshawaf et al., the trend estimates in the research do demonstrate the potential for GNSS PWV to provide accurate information should the adequate length be achieved. The physical interpretation for GNSS and ERA- Interim PWV trends per year does also demonstrate the change in atmospheric moisture due to rising temperatures per year.
- Paragraph 9: This part of the paper attempted to study the behaviour of GNSS PWV during major ENSO activities, as presented in Fig. 6 and 7. With the predefined indicators confirming the occurrences of ENSO, the two NINO regions were selected according to their geographical locations to Papua New Guinea, and their differences in indicators in SST anomalies values - however, your point on the different phases and the significance of the correlations is well noted and will require proper discussion/ changes.
- Weekly OISSTa was seen as more suitable to account for missing GNSS data per week during ENSO event and because OISST is beneficial with the higher resolution in SST during the ENSO event. The discussion about precipitation to explain the PWV and ENSO was referenced to reports and newspaper articles during these events, as precipitation datasets from the local meteorological office was not reliable during these events. Should a precipitation dataset be taken from climate models, further assessments of the rainfall dataset would bring us off the research scope.
- Paragraph 10: The discussion and conclusion of the paper was intended to bring out the large research gap in GNSS Meteorology and extreme weather monitoring in general over this particular region of the world. However, suggestions and recommendations by the reviewer on reporting significant findings as well as the need for a major revision of the manuscript are well noted and appreciated, which the authors will now look into again.