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Comment on nhess-2021-119

Anonymous Referee #1

Referee comment on "Robust uncertainty quantification of the volume of tsunami ionospheric holes for the 2011 Tohoku-Oki earthquake: towards low-cost satellite-based tsunami warning systems" by Ryuichi Kanai et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2021-119-RC1>, 2021

The paper developed the method to identify ionospheric hole generated by tsunami more precisely than the previous method. I am interested in their method and believe that this method is scientifically important. There are some problems need to be answers clearly before the paper is published.

The major comments

- They used sparse data where 95 % of the GNSS receivers are randomly removed from the observed data. However, they only show one example of the sparse data set. If you randomly removed 95 % of data. You can generate a large number of sparse data sets. Therefore, you can analyze how the variation of data sets affects to the results. If you remove 95 % of data randomly, some of your data sets may have only a few receivers in the ionospheric hole. We want to know how those data sets affect to the results.
- In all of the maps in Figures, the position of the Japan trench should be shown because we all knew that the tsunami initial surface uplift of the 2011 Tohoku-oki earthquake was located at landward from the trench because it was underthrust earthquake, Therefore, the ionospheric hole was also better to be located at landward from the trench. By looking at Figure 8, a part of ionospheric hole at 6:12:00 and 6:16:00, (a2), (a3), (b2), and (b3), are located at oceanward for the Japan trench. Please explain reasons for those. At 6:08:00 is 21 minutes after the earthquake, the ionospheric hole is still the same as the initial tsunami surface uplift zone (a1 and b1 in Figure 8). What are reasons that the hole increased the areas to seaward (eastward) at 25 and 29 minutes after the earthquake?
- I am sure that it is important to identify the initial uplift area for tsunami early warning purpose. However, it takes 20-29 minutes to estimate the area. Therefore, I believe

that this method should be more effective and powerful by combining the existing method or some other method recently developed. The authors should discuss those in the paper.

Minor comments.

- In page 3, "Is the assumption of altitude of 300 km sufficient for day and night times?"
- In page 4, "6:46:30 (UTC) and 6:46:18(UTC)" should be "5:46:30 (UTC) and 5:46:18(UTC)"
- In Figure 5, three dimensional plots (c, d, e, and f) are difficult to find exact the confidence levels. They may be better to plot in the map views (2D) with some cross-sections.
- Please explain clearly how do you chose the locations of eight triangles in Figure 6 and locations of each time at eight directions in Figure 7.