

## ***Interactive comment on “Combinatorial observation ionospheric characteristics during tropical cyclone Debbie passing eastern Australia in 2017 using GPS and ion sounder” by Fuyang Ke et al.***

### **Anonymous Referee #2**

Received and published: 5 November 2019

Since the authors already revised this manuscript along comments on Referee #1, the following comments are applied to the revised manuscript which the authors posted on 5th September as AC1.

In this manuscript, the authors examined the ionospheric disturbances associated with cyclone Debbie. Using GPS data (ROTI and S4 index) and ionosonde data (foE, foF1, foF2), the authors showed that, as the cyclone passed, the ionospheric disturbances were generated and these parameters varied. Even though a magnetic storm developed simultaneously in passing of the cyclone, the generation of these ionospheric

C1

disturbances seems to be related to the cyclone. The purpose of this paper is important and suitable for the publication of the journal. However, the reviewer thinks that the major revisions are still inevitable along the following comments to publish this manuscript. Withdraw and resubmission of this manuscript are also preferable.

Major comments:

1. Even though the authors had improved the English of the manuscript, there are a number of incomprehensible expressions. The referee strongly recommended the further improvement of the English of this manuscript using professional English editing services.
2. Much more detailed informations of the track of the cyclone are important. The authors showed only the times of the landing on Hook Island and leaving from Brisbane. Since cyclone Debbie may affect ionospheric disturbances more than 2 days, the positions of the cyclone on shore are very informative because the enhancements of ROTI are appeared in the limited period. The information of this cyclone is available such as Bureau of Meteorology of Australia (<http://www.bom.gov.au/cyclone/history/debbie17.shtml>). In addition, wind speed and the center pressure are also informative.
3. As shown in Figure 3, the authors used STEC data derived from PRN23, PRN01, PRN11. Why don't you use STEC data derived from the other GPS satellites ? Since the authors used data derived from only 3 satellites, the variations of ROTI in daytime were not examined. In daytime, is there no STEC data showing the variations of ROTI ? ROTI data in daytime is also very useful in comparison with the ionosonde data.
4. In Figure 3, in addition to the previous comment, ROT for PRN01 and PRN11 are fluctuated but that for PRN23 is not. The authors explain that “the IPP trace of GPS PRN23 over TOW2 station is far away from the cyclone.” To confirm this explanation, the traces of IPPs for PRN23 are necessary. How far the IPPs for PRN23 is from the cyclone ? On the other hand, the variations of ROT determined by PRN01 and PRN11

C2

appeared around 12UT. This may be related to the distance between the cyclone and IPP for PRN01 and PRN11. In order to show how effective the distances between the cyclone and IPPs are for the variation of ROT, the tracks and positions of IPPs for PRN01 and PRN11 are also important.

5. The comments #3 and #4 are also applicable to S4 data. How close IPPs were close to the cyclone when the scintillations occurred ?

6. In Figure 5, the authors show a map of S4 intensity. The authors explained that “What is more that the intensity and number of the points of  $S4 > 0.2$  above the area of  $18^{\circ}\text{S} - 25^{\circ}\text{E}$  in the latitude and  $150^{\circ}\text{E} - 155^{\circ}\text{E}$  in the longitude around tropical cyclone center ( $B = 19.6^{\circ}\text{S}$ ,  $L = 149.8^{\circ}\text{E}$ ) is stronger and larger than those above the other area.” From the referee’s view, the enhancement of S4 index is also appeared in the northern area ( $0\text{S}-18\text{S}$ ,  $145\text{E}-150\text{E}$ ). Is not this enhancement related to the cyclone ? Even though the authors may explain this enhancement is related to the geomagnetic storm, we cannot distinguish whether this enhancement is due to the geomagnetic storm or the cyclone because the authors do not show the time of each IPP position. Basically, the enhancement of the S4 index due to geomagnetic storms appeared in wide longitudinal area. Why do not the enhancement of S4 index appear in the other longitudinal area ? More detail analysis of this data is needed.

7. In Figure 6, foE in Brisbane during 26th to 29th March was somewhat fluctuated as compared to Learmonth and Townsville. Is this fluctuation not related to the cyclone ?

8. Page 9 line 225: The authors explained that “the periodic anomaly of foF1 in those day might be due to ionosonde noise.” The small fluctuations of foE is also noise ? How about ionograms in this period ?

9. Page 9 line 239: What does “vertical gravity wave” mean ? Basically, gravity waves cannot propagate vertical direction.

10. Page 10 line 255: The authors described “some neutral molecules ( $\text{N}_2$ ,  $\text{O}_2$ ) in E

C3

layer will be taken into the ionospheric F1 and F2 layer. “ Most of the neutral molecules, such as  $\text{N}_2$ ,  $\text{O}_2$ , distribute around the altitude of 150 km. It is possible that these molecules might be transferred to F1 region by some turbulences. However, are these molecules transferred to F2 region by any turbulences ?

11. Page 10 line 260: The authors described the generation mechanism of equatorial plasma bubbles, which cause scintillations of GPS signals. As for the source of the bubbles, the ionospheric perturbations are important. On the other hand, as for the growth rate of Rayleigh-Taylor instability, not the electric field perturbation but the eastward electric field is important. The referee wonder if perturbations always generate the eastward electric field ? In the present case, the growth rate happens to be larger ? This explanation cannot be applied to all the cases for ionospheric disturbances by cyclones.

Minor comments:

1. Caption of Figure 1 : The locations the ionosonde are shown by Blue pentagrams not Blue triangles.

2. Page 3 line 92: What is “ellipsoidal distance” ?

3. Equation (1) : The definitions of ROT and ROTI were originally submitted by Pi et al. (1997).

4. Page 6 line 168: “midnight of 27 March” is 0UT or 24UT on 27 March ?

5. The location (latitude and longitude) of the cyclone center is shown by (B, L), e.g. page 7 line 181, page 10 line 277. This expression is not familiar with those related to Aeronomy field.

6. Page 9 line 239: Shao et al. (2013) is not listed in Reference.

Reference:

Pi et al., Monitoring of global ionospheric irregularities using the Worldwide GPS Net-

C4

work, *Geophys. Res. Lett.*, 24, 18, 2283, 1997.

Interactive comment on *Ann. Geophys. Discuss.*, <https://doi.org/10.5194/angeo-2019-72>, 2019.