Interactive comment on "Quasi 10-day wave modulation of equatorial ionization anomaly during the Southern Hemisphere stratospheric warming of 2002" *by* Xiaohua Mo

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We very appreciate the referee's comments for our work and manuscript. Here are our reply comments. All major revisions are marked in yellow highlights.

Manuscript angeo-2019-43 Review on "Quasi 10-day wave modulation of equatorial ionization anomaly during the Southern Hemisphere stratospheric warming of 2002" by Xiaohua Mo

This paper is focused on the possible influence of the quasi 10-day planetary waves (PWs), registered in the high-latitude polar stratospheric temperature before and

around the Southern Hemisphere (SH) sudden stratospheric warming (SSW) in 2002, on the oscillations of the equatorial ionization anomaly (EIA) crests and their Total Electron Content (TEC). The locations of the EIA crests are calculated from the observations of the two GPS stations in China which are situated near the northern and southern EIA crests and the TEC data are derived from the International GNSS Service global ionospheric TEC maps in Asia. The SH SSW is described by the temperature and zonal mean zonal wind taken from the NCEP while the goemagnetic and solar variability are characterized by the Kp-index and solar radio flux F10.7 respectively. The period from July 21 to October 18, 2002 is considered (day numbers 200-300) and the quasi-10-day variability associated with the SSW is found in both the location of the EIA crests and the TEC between days 220-290. The author suggested that the observed ∼10-day oscillation of the EIA region is generated through modulating the equatorial fountain effect.

The topic of the paper is certainly appropriate for the journal. In general, the paper is written clearly; actually it follows the pattern of the previous paper of the author, Mo et al. (2014) cited here. This study is certainly useful for the scientific community working on the vertical coupling of the atmosphere-ionosphere system, however I think that it has serious deficiencies. Due to this I will suggest the publication of this paper but after serious revision and addressing the comments mentioned below.

Major comments: (i) I have serious concern about the significance of the observed ∼10-d oscillations particularly in the location of the EIA crests because the amplitude of these oscillations is only around 1.5° (Fig. 5a). Additionally, in Lomb-Scargle periodograms these oscillations are significant only above 90% confidence level (Fig. 3) that is not enough. It has been mentioned above that this study is similar to the previous one Mo et al. (2014). However, while there the quasi 16-day oscillations of the EIA crests were evident even in the raw data here the quasi-10-day ones are not. Usually only waves with significance at least above 95% confidence level are considered in studying the atmospheric and ionospheric perturbations. The author does not mention

anything about the error in calculating the coordinates of the EIA crests. Without know-ing the error in calculating the MLAT of the EIA crests it is difficult to accept the 10-day variability of the EIA region as significant one. Answer: The perturbations amplitude in EIA region during SH SSW are smaller than those during NH SSW (Olson et al., 2013), so the Quasi 10-day wave in EIA region is not quite obvious. To make the results more credible, the 90% confidence level has been changed to 95% confidence level in Fig-ures 4. It can be seen the quasi 10-day periodic component of most EIA parameters can reach 95% confidence level. Moreover, the significance levels of quasi 10-day os-cillations revealed by the Morlet wavelet spectral analysis are higher than 95%. The error of the collected EIA crest latitude according to IPP trajectory is determined by the selected ionospheric shell height. Due to ionospheric variation, the shell height varies in different time and condition. Now, the constant shell height is used in almost all TEC derivation method, and the value of this height affects the resolution of the IPP location and the derived TEC values. So it is difficult to estimate the error of the EIA latitude. In the original manuscript, we only roughly estimate the error of the latitude from the sample rate of the raw GPS data according to the IPP velocity in the ionospheric shell.

(ii) In order to propose a mechanism for generating the 10-day variability of the EIA region the authors used indirect approach based on some general references on dy-namics as well as references connected with the SH SSW in 2002. The important citations as: Eswaraiah et al. (2018) or Olson et al. (2013) which however present ground-based measurements at high latitudes or at Peruvian longitude sector cannot be considered as serious evidences because the author investigates different region, low latitudes over China. I cannot understand why the author does not use a meteor wind data from a Chinese radar at low latitudes and to check if there are quasi-10-day wave or modulated tides which are able to affect the fountain effect. Further, to see if the electric currents are modulated the author may consider the perturbations in the geomagnetic fields revealed from magnetometer measurements. Only then a solid evidence can be presented in support of the suggested mechnism. Answer: The Meteor and MF radar was ever set up and was tested after 2003 in China, so the direct

observations of MLT neutral wind are not available in China low latitude during 2002 SH SSW. The equatorial electrojet (EEJ) estimated by geomagnetic field cannot be obtained in China sector, because the geomagnetic field data in Bac Lieu in Vietnam are missing during the period from Aug 28, 2002 to Sep 26, 2002 (day number 240-269). In order to compensate this weakness, the EEJ estimated by geomagnetic field in Indian sector is added in revised manuscript. The EEJ in Indian sector also exhibit significant quasi 10-day periodic component.

(iii) Important studies on atmospheric dynamics and the ionospheric response to the SSW events are not cited. Concrete comments: P. 2, lines 37-38: Please, add the fol-lowing references: Chau et al. (GRL, 36, L05101, 2009, doi:10.1029/2008GL036785) giving evidence for the vertical plasma drift changes during the SSW and Pancheva and Mukhtarov (JASTP, 73, 1697–1702, 2011, doi:10.1016/j.jastp.2011.03.006) pre-senting which main characteristics of the EIA and how they are changed during the major SSW. Answer: These references have been added in the introduction part of revised manuscript.

P. 2, line 38: Please, add Jin et al. (JGR, 117, A10323, doi:10.1029/2012JA017650) where for the first time a comparison between the results from a whole atmosphere ionosphere coupled model (GAIA) with the COSMIC and TIMED/SABER observations during the major SSW in January 2009 was presented. Answer: This reference has been added in the introduction part of revised manuscript.

P. 2, line 41: "Since planetary waves in the Southern Hemisphere (SH) generally have smaller amplitudes than in the Northern Hemisphere (NH). . . .." generally this is true only for the SPWs; the climatology of some other well known PWs, as for example, the quasi-2-day W3 wave or the quasi-6-day W1 wave are both stronger in the SH. Answer: Thank you for your remind. "planetary waves" has been changed to "stationary planetary waves".

P. 3, line 79:. . ... $\sim\pm15°$ N MLAT. . .. please, delete N Answer: Revised.

P. 4, line 117: "In additional, we . . . . . ."; please, delete al Answer: Revised.

P. 5, lines 126-127: "Note that quasi 10-day oscillations of northern and southern EIA crests are in-phase, which. . ."; sorry, both oscillations are not in phase; the oscillation of the NH crest indicates a delay of a day with respect to the SH one. Please, calculate the cross-correlation function between both times, particularly between days 220-290 when they have large amplitudes, and will see that the largest cross-correlation will be found at different from zero time lag. Answer: It is a very good comment. According to this suggestion, the cross-correlation function is used to reveal the phase relationship between northern and southern EIA crests. The results show that the quasi 10-day wave of northern EIA crest delay 1 day behind southern EIA crest.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2019-43/angeo-2019-43-AC2-supplement.pdf

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