Response to referee 1:

This study present the interesting shape characteristics of the multiple peaks at Es layer altitude in RO profiles, special distribution of the RO profiles with Es layer characteristics, and comparison of the RO profiles between Lidar observations and ionogram. However, the discussions are fine, but it is not clear enough. The current version of this paper needs further consideration for publication before moderate and careful revision, and the two points in specific comment are the main reason why I make this paper as major revisions.

Specific comment:

1. Based on the current version of the paper, the multiple peaks Es layer have been discovered and mechanically explained by Smith & Miller (1980) and Wakabayashi & Ono (2005), respectively. What's different between their and the authors' findings for the multiple Es layer?

Answer: We are not claiming that this is the first finding of multiple peaks Es. We are only trying to demonstrate that GPS RO could be used to detect this kind of structures. The main difference between our results and others are: We are using RO measurement, while they used ISR or rocket measurements. So our multiple peaks Es should have a relatively larger horizontal scale since small one could not be illustrated in RO signals, while the multiple Es by ISR/Rockets could be horizontally small or large one. Couple sentences have been added in the revision to clarify this point in the first paragraph of the discussion section.

2. Based on the section 3 and section 4.3 of the current version of the paper, the authors connect the Es layer and wind shear theory by using the simultaneously occurrence of RO Es layer characteristic SNR profiles distributing in a broad region. The connecti on is weak based on the current description in the paper, which only show the Es layer can be non-sporadic. Please describe more detail of the connection or present the strong evidence to support the connection.

Answer: Yes, based on the current content, it is hard to connect the Es occurrence and the wind shear theory. Multiple observations (e.g.: wind profile) and theoretical simulation might be needed to address this issue. However, we think it is not necessary to do this in this paper because the mechanism of Es is well-known. Based on COSMIC RO data, Chu et al. (2014) have examined the wind shear theory in very detail. The referee can read that paper for details.

Minor comment:

1. In line13 in page 9207, "while the DC electric field makes a significant contribution to the formation of the upper layer," please use "direct current (DC)" to replace "DC"

Answer: It is done. Thanks for pointing this out.

2. In line 10 in page 9209, "In this study, only the cases that have maximum S4 index calculated from 50 Hz SNR larger 0.3 are considered." I think the S4 index information used in this study is from scnLv1 files, the SNR is from atmPhs files and TEC is derived by using the excess phase recorded in atmPhs

files. Please describe the relations between S4 index, SNR, TEC and their recorded files.

Answer: Thanks for the suggestions. Actually the S4 index is calculated from the 50 Hz SNR of the occultation antenna, not from the scnLv1 files, which is calculated based on 50 Hz amplitude observations by the POD antenna. We revised the text accordingly to make this point clear.

3. In line 24 in page 9212, "This area is defined as the Es Occurrence Area (EOA), as shown……" should be replaced by "This area is defined as the EOA, as shown……" because the abbreviation has been defined in line 18 in page 9212.

Answer: It is done, Thanks.