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Atmospheric Measurement Techniques Discussions

Interactive comment on "Case study on complex sporadic E layers observed by GPS radio occultations" *by* X. Yue et al.

Anonymous Referee #2

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Reviewer comment on manuscript "Case study on complex sporadic E layers observed by GPS radio occultations"

By Xinan Yue et al.

On the basis of GPS RO-retrieved Es layer data collected by a number of satellite missions combined with ground-based lidar and ionosondes, the authors study multiple Es layer structure and non-sporadic property of Es layer in this manuscript. A number of cases obtained from GPS RO measurements are presented to support the existence of the multiple Es layers. Although qualitative comparisons between different measurements have been made, no quantitative analysis on the characteristics of the complex Es layer is performed in the manuscript. In addition, there are a number of

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issues and questions that are required to further clarify and settle. I believe some of the data presented in this manuscript might be interested to ionospheric community. However, because of the comments below, there is still much room left for the authors to improve their manuscript. At this moment, I cannot recommend the acceptance of the manuscript for publication in its present form. My comments are given below.

1. The criteria used for identifying multiple Es layer event from GPS SNR fluctuations and TEC perturbations are not quantitatively defined in this manuscript. This is a key issue in doing a scientific paper to study the object that the authors aim at.

2. Introduction Section should be heavily revised. There are a number of questionable sentences required to clarify and amend. For example,

- Line 26-29, in addition to molecular oxygen, a large number of neutral atoms and molecules are responsible for the generation of the free electrons in E region through photochemical reaction processes. These sentence should be modified. - The sentences from line 96 to 101 are misleading. Plasma instability is a physical process responsible for the generation of plasma irregularities in ionosphere. In sporadic E region (about from 90 to 150 km), gradient-drift instability, two-stream instability and neutral turbulence-induced plasma irregularities associated with K-H instability are the primary mechanisms to generate the electron density irregularities at different sizes (e.g., Kelley, 1989). Therefore, plasma instability itself will not be responsible for the vertical lift or deformation of the Es layer formed by wind shear convergence effect. These sentences should be heavily revised. - Line 107-110, in addition to ISR and rocket, the use of coherent scatter radar can effectively detect and investigate complex Es layer (Chu and Wang, 1999; Hysell et al., 2012), which is a very cost-effective means comparing to ISR and rocket.

3. The authors use the acronym “Es” to stand for the sporadic E layer throughout the manuscript. This might mislead the readers who are not familiar with the historical development of the usage of Es. Notice that Es is a conventional (or historical)

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terminology to describe the echo traces in E region level in ionogram, which are resulted from scattering/reflection from plasma irregularities that appear sporadically in time and space. On the basis of its appearance in ionogram, the Es trace can be categorized into nine types, namely, f-, h-, l-, c-, q-, r-, a-, s- and d-types (Piggott and Rawer, 1978).With the advent of various instruments that have capability of detecting echoes from plasma irregularities in ionospheric E region, the terminology of Es now is widely used by the ionospheric community to represent the spatial inhomogeneity of plasma density in E region, including layer structure, plasma irregularities, plasma cloud, plasma patch, and so on. In order to avoid misleading and confusion, the use of terminology should be greatly cautious.

4. Line 327-328, note that the wind shear theory is invalid for the formation of layer structure through convergence of ionizations below 80 km due to tremendously high collision frequency between ionization and neutral particles. As a result, the L1 SNR and TEC perturbations below 80 km cannot be interpreted as Es layer formed by wind shear.

5. Experimental results show that the thickness of Es layer is usually in a range 0.5-4 km (Houminer et al., 1996; Zeng and Sokolovskiy, 2010; Chu et al., 2011). Therefore, the interpretation of Es traces with exceedingly large vertical extents of tens of km shown in Figure 10 as sporadic E layer is inappropriate and questionable. As matter of the fact, different plasma irregularities will result in different types of the Es traces in ionogram, and some of them are resulted from the excitations of the plasma instabilities in E region. This topic has long been investigated by the scientists for more than 5 decades (Bowman, 1960; Goodwin, 1966; Goodwin and Summers, 1970; From and Whitehead, 1986; Barnes, 1992; Hussey et al., 1998; Maruyama et al., 2006). Therefore, care should be taken in comparing the Es traces with other measurements. Because the main theme of this manuscript is to study the wind shear-induced Es layer, the Es traces caused by other mechanisms should be carefully discerned and ruled out in comparison.

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6. It is generally accepted that wind shear-induced ion convergence effect is the cause of the sporadic E layer. Although the physical mechanism governing the formation of the Es layer is clear, its occurrence in time and space is till unpredictable. This is the essence of the term of the “sporadic”. Therefore, the statement of “It strongly supports the non-sporadic property of Es.” in Abstract and Conclusion is not appropriate and should be revised.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/7/C3890/2014/amtd-7-C3890-2014-supplement.pdf

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