Referee# 2

Summary

I wish to appreciate that the authors have slightly improved the manuscript, whereas the key issues have been unresolved. I had to repeat some off my previous comments, which should be incorporated in their revision.

We thank Referee# 2 for all the comments and suggestions, which by the way improved substantially this report and we acknowledge you for your time on it. Please see below our answers.

Major Comments:

1. The authors have claimed the solar activity in 2009 as something comparable with the Maunder Minimum, citing Zharkova (2020). However, this is probably not true. As I have pointed out, recent studies have proven that the solar activity was much more quiet during the Maunder Minimum than during 2009, on the basis of the cosmogenic isotopes (DOI: 10.1051/0004-6361/201526652; DOI: 10.1051/0004-6361/202140711), the sunspot records (DOI: 10.1093/mnras/stab1155; DOI: 10.3847/1538-4357/abd949), and the visual coronal structures (DOI: 10.1051/swsc/2020035). The authors should cite all these references (not only Carrasco et al., 2021) and keep their implication more conservative.

This part of the text was rewritten (see P8-9, L192-201) and the references suggested were included.

Using Johann Heinrich Müller's sunspot observations from 1709 (Figure 5 of Hayakawa et al. 2021a), and the sunspot catalog published by the Kislovodsk Mountain Astronomical Station of the Central Astronomical Observatory at Pulkovo for the recent solar cycles (1996–2019), Carrasco et al. (2021) showed that one of the most active years in the Maunder Minimum (1709), was still less active than most years in the Dalton Minimum and also less active than those of the most recent solar minima. Additionally, they mentioned that only the solar activity levels in 2008, 2009, and 2019 were similar to or lower than (in the case of 2008, see Figure 2 of Carrasco et al. 2021) the most probable active day fraction value for 1709. This reinforces how special is of the period chosen here to analyse the possible dependence of ILs on geomagnetic activity. For more detail *about Maunder Minimum, see for example Usoskin et al. 2015, 2021; Carrasco et al. 2021; and Hayakawa et al. 2021a,b).*

2. If they wish to state the significance for 2009 in a centennial timescale, their statement on the F10.7 in 2009 does not help the reader to understand the solar variability in the long-term context. This should be replaced to the discussions on sunspot number (after revisions in 2014-2016), citing DOI: 10.1007/s11214-014-0074-2 and DOI: 10.1007/s11207-016-1014-y.

The purpose of this work is to analyze the behavior of ILs to geomagnetic variations during the daytime period. For this, we chose the period 2009 which was considered by the aeronomy community perhaps the quietest of the radio observation era. Following the reviewer suggestions, we have revised several studies about the Sun variability and decided to be superficial in this context, because the scope of this study is not the solar variation, but the analysis of the ILs with respect to geomagnetic variations assuming very little influence or none from the Sun radiation (well-known atmospheric forcing). Thus, we have chosen to be very conservative in the Sun variability discussion, as you can see in this revised version.

3. It is understandable for the authors to value their own studies. Everyone does, indeed. However, the authors have mentioned other authors' studies in the discussion. In this case, they must appropriately address what other authors have achieved in the introduction (even if it is for other geographic sectors).

We understand your point. We have added in the introduction a revision made of several other studies of ILs. Please see P3, L60-74.

Fujitaka and Tohmatsu (1973) reported that the solar semi-diurnal atmospheric tide can be the dominant cause of the intermediate layers at night and that the vertical drift of the ionizations by the Sq electric field seems to modify the altitude variation of the ILs during this time. Szuszczewicz et al. (1995) found that the ILs are observed throughout the day and in all latitudes that covered the northern and southern hemispheres. Besides that, they also reported the formation of ILs at high altitudes (> 170 km) and a monotonic descent to lower altitudes at rates as high as 8.5 km/h. Rodger et al. (1981) noted that the ILs over South Georgia (54oS, 37oW) are characterized by a prior downward movement of the F-layer, followed by the formation of the intermediate layer and its subsequent drift *downwards to about 140 km. They also mentioned that initially this downward movement of the ILs can be at the same rate as the F layer, but decreases as the ILs attained lower altitudes. Mridula and Pant (2021) studied the behavior of ILs over the equatorial location of Thiruvananthapuram and noted that the occurrence of ILs over this sector is higher in the summer and winter solstice and lower in equinoxes. They also showed that the occurrence of this layer is higher in the solar minimum than in the solar maximum period. The possible influence of the gravity waves in determining these characteristics is also discussed by the authors.*

4. I do not think the Kp index is the best tool to visualize the responses of the IL to the overall level of geomagnetic activity. The authors should redo their analyses with the Dst index, which is much more quantitative than the Kp index.

Indeed, the Dst index is much more quantitative than the Kp index and very adequate to case studies due to the better temporal resolution. Our work search for responses of the IL's to geomagnetic activity based on a global scale, and in this case we choose to use the planetary index Kp, largely used by our community and supplied on a daily basis. Also, we are using large temporal samples, that is, one-hour window of IL data considering the previous 9 hours of the geomagnetic condition for about 121 days (one whole season). Therefore, the temporal resolution is not relevant here, as well as the Dst variation in such a range of time. As it was shown in the last revision, we did perform some analysis to answer a question of reviewer #1 that was very similar to the question of reviewer #2 now (see Figure 1 below). It was verified that the increase of ΔKp is compatible with an increase of Bz to south and a decrease of Sym-H, evidencing in this way that the magnetic disturbances considered in our study are associated with the direction and intensity of Bz and with the intensity of Sym-H. So, we do believe that a new analysis with Dst index wouldn’t give any different light compared with those got with ΔKp.

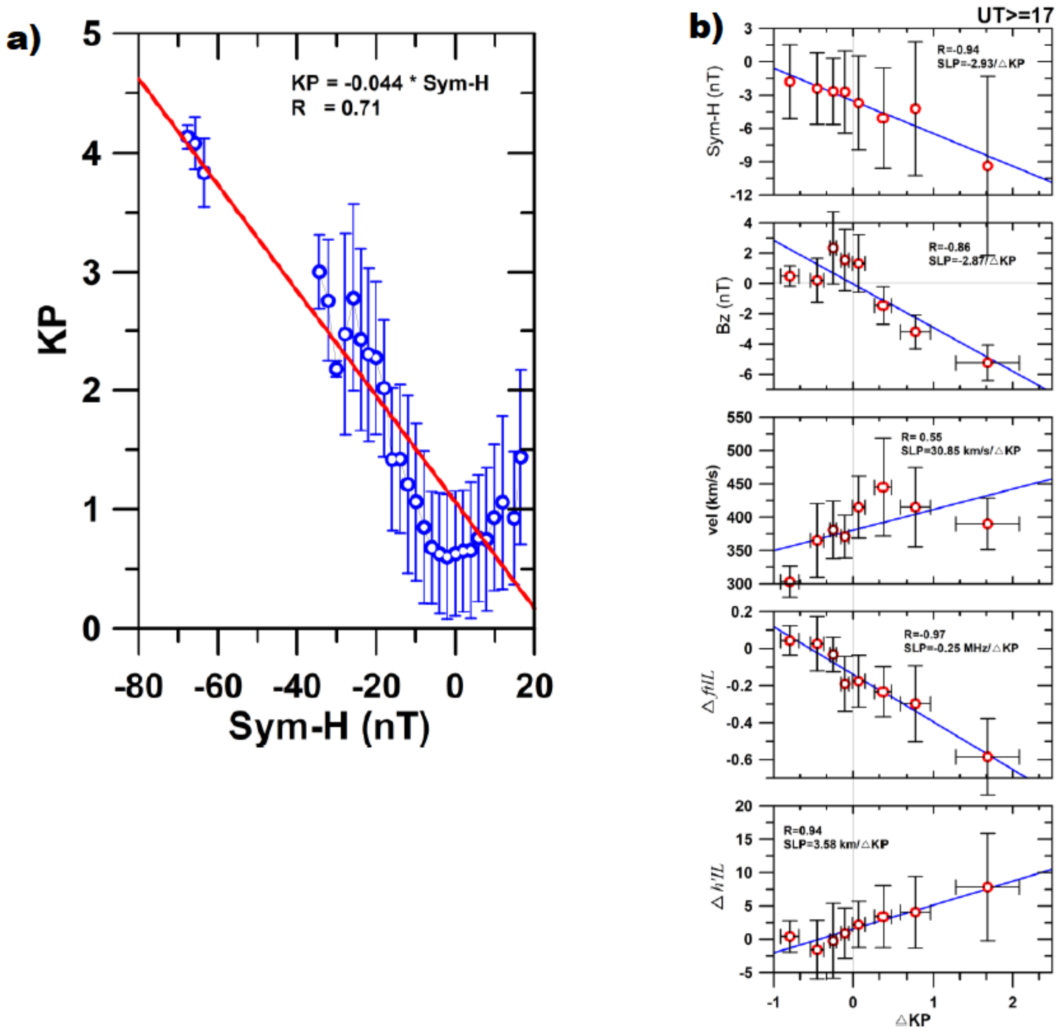

Figure 1 – a) Dispersion diagram between the kp index in respect to Sym-H values for the year of 2009. b) Variability of Sym-H, IMF Bz intensity, solar wind velocity, ΔftIL and Δh’IL in respect to Δkp.

Minor Comments

P1L26: ambient ionosphere => ambient ionosphere since 1947 (if the authors insist in using the F10.7 index)

Done.

P2L30 Cite Ken Tapping's works here.

Done.

P8L181: Johann Heinrich Müller’s sunspot observations from 1709 => Johann Heinrich Müller’s sunspot observations from 1709 (Figure 5 of DOI: 10.3847/1538-4357/abd949)

Done.

P8L183: those of the most recent solar cycles => those of the most recent solar minima

Done.

P8L184: similar to => similar to or lower than.

Done.