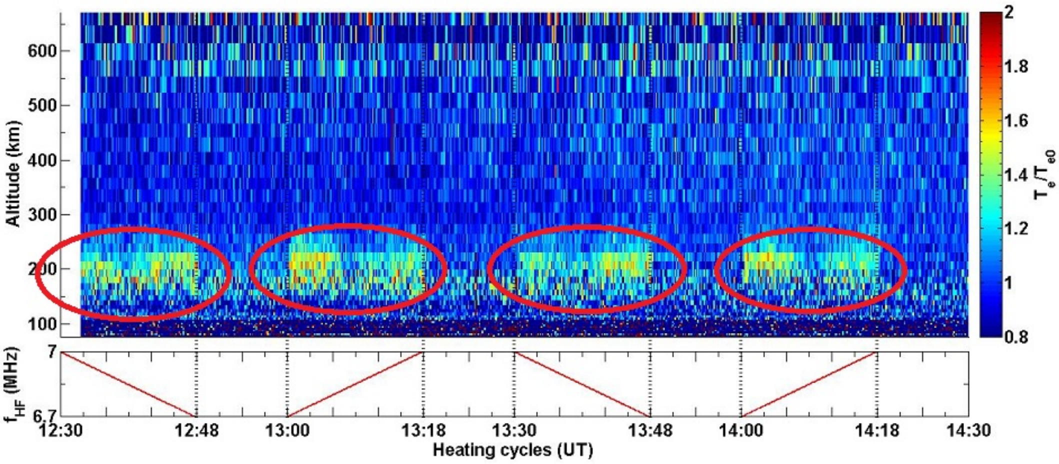
Reviewer 2

Thank you for the comments and suggestions. The comments given by reviewer are listed in black and ours replies are listed in red as below:

Comments to the Author

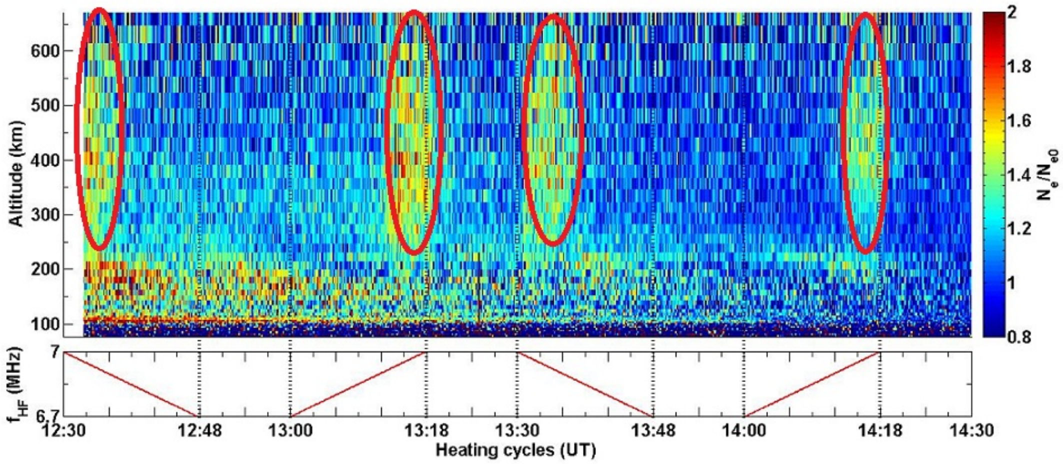
1. It is not clear what is new in the manuscript. Dependencies of the HFPL and Langmuir dispersion characteristics on electron density and temperature as well as pump frequency are well known since decades. Also, electron gyroharmonic results where, for example, discussed already by Honary et al. (JGR 100, 21489, 1995). Further, several papers have been published by the authors from the same two hours of experiments, even with the same figures(!), but no information is given on how these papers relate to each other and to the present treatment.



The enhanced electron temperature as a function of pump frequency

Fig 1. the enhanced electron temperature as a function of pump frequency

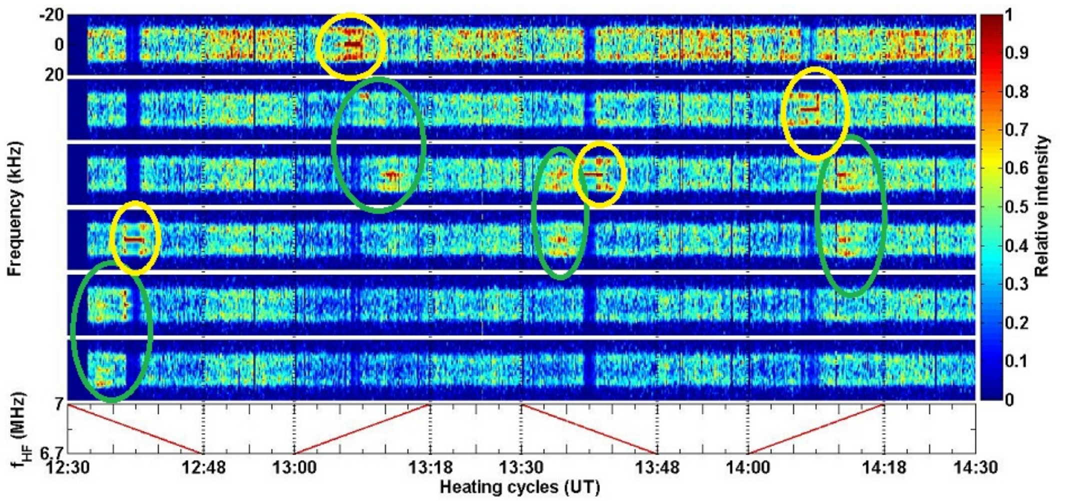
The fact is that from the experimental observations performed in the interval of 12.30 – 14.30 UT on 11 March 2014, we find **six** interesting phenomenon (scientific questions), namely,
(1) **the enhanced electron temperature as a function of pump frequency** as shown in **Fig 1**. This result was reported in published paper [*Wu, J., J. Wu, M. T. Rietveld, I. Haggstrom, H. Zhao, and Z. Xu, The behavior of electron density and temperature during ionospheric heating near the fifth electron gyrofrequency, J. Geophys. Res. Space Physics, 122, doi:10.1002/2016JA023121, 2017; Wu J, J. Wu, H. Zhao and Z. Xu, Analysis of incoherent scatter during ionospheric heating near the fifth electron gyrofrequency, Plasma Sci.Technol., 19(4), doi:10.1088/2058-6272/aa58db, 2017.*].



The extending enhancement in electron density

Fig 2. the altitude extending enhanced electron density

(2) **the altitude extending enhanced electron density** as shown in **Fig 2**. This result was reported in published paper [*Wu, J., J. Wu, M. T. Rietveld, I. Haggstrom, H. Zhao, and Z. Xu, The behavior of electron density and temperature during ionospheric heating near the fifth electron gyrofrequency, J. Geophys. Res. Space Physics, 122, doi:10.1002/2016JA023121, 2017; Wu J, J. Wu, H. Zhao and Z. Xu, Analysis of incoherent scatter during ionospheric heating near the fifth electron gyrofrequency, Plasma Sci.Technol., 19(4), doi:10.1088/2058-6272/aa58db, 2017.*].



The HFIL in the HB is extending in altitude (green circle), whereas the HFIL in the GB is not (yellow circle).

Fig 3. a remarkable extension of observing altitudes of the HFIL

(3) **a remarkable extension of observing altitudes of the HFIL in the HB** as shown in **Fig 3**. This result was reported in published paper [*Wu, J., Wu J., Rietveld M. T., Haggstrom I., Xu Z., Zhao H. The extending of observing altitudes of plasma and ion lines during ionospheric heating. Journal of Geophysical Research: Space Physics, 123(1), 918-930, doi.org/10.1002/2017JA024809 2018*].

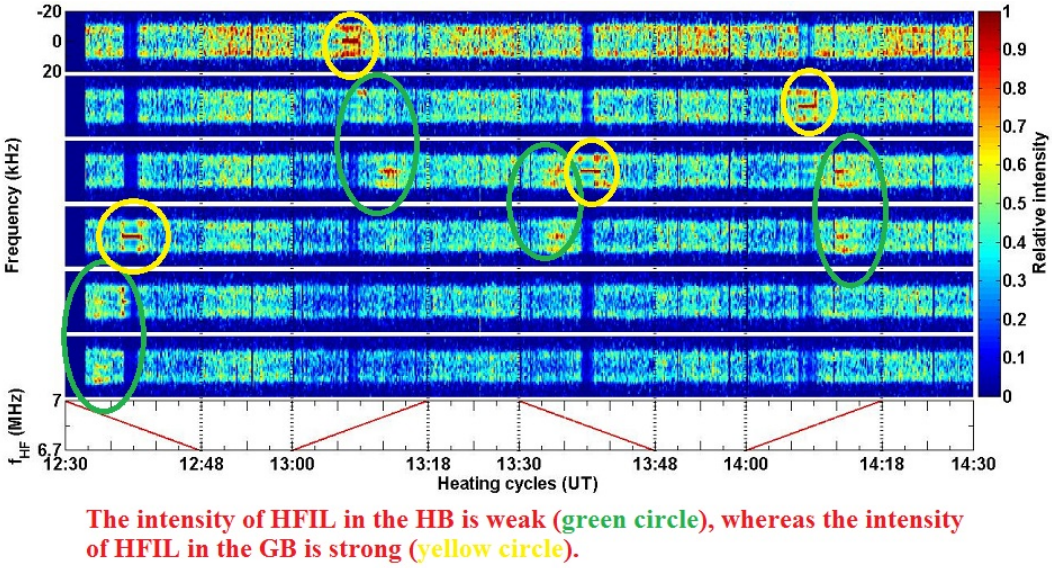


Fig 4. the variation in the intensity of the HFIL as a function of pump frequency

(4) **the variation in the intensity of the HFIL as a function of pump frequency** as shown in **Fig 4.** This result was reported in published paper [*Wu J., Wu J., Rietveld M. T., Haggstrom I., Xu Z., Zhang Y., Xu T., Zhao H. The Intensities of High Frequency-Enhanced Plasma and Ion Lines During Ionospheric Heating. JGR Space Physics. 124(1). P.603-615. doi:10.1029/2018JA025918, 2018.*]. In addition, as a phase work, we reported the original idea about the intensity of the HFIL in paper [*Altitude and intensity characteristics of parametric instability excited by an HF pump wave near the fifth electron harmonic, Plasma Sci. Technol., 19(12), 2017*.]

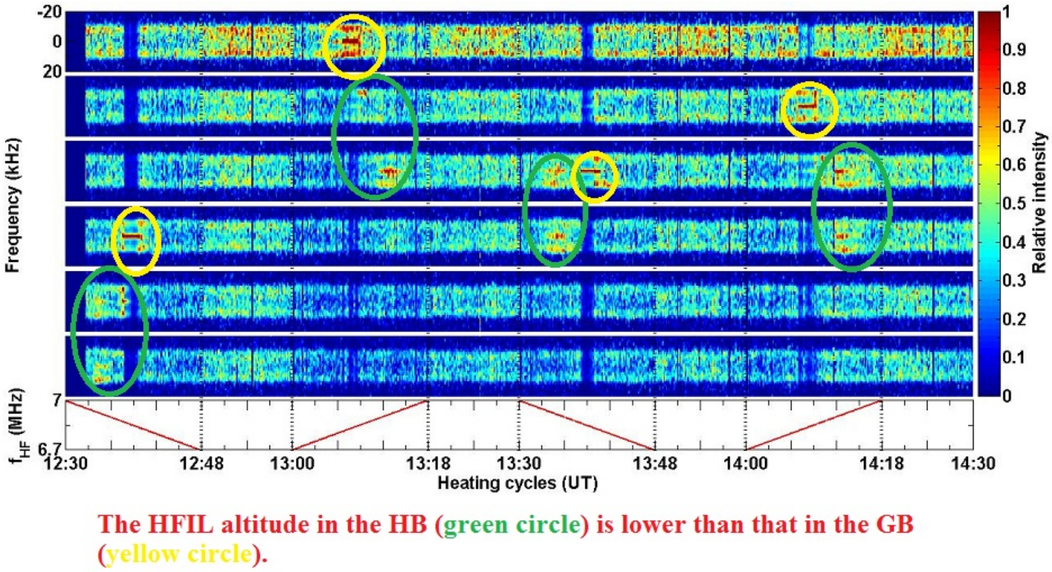


Fig 5. a systematic variation in the altitude of the HFIL as a function of pump frequency

(5) **a systematic variation in the altitude of the HFIL as a function of pump frequency**, namely, the altitude of the HFIL in the HB is lower than that in the GB, as shown in **Fig 5.** This result was reported in published paper [*Wu, J., Rietveld, M.T., Häggström, I., Zhao, H., Xu, T. & Xu, Z. (2018). Systematic variation in observing altitude of enhanced ion line by the pump near*

fifth gyroharmonic. Plasma Science and Technology, 20(12), 125301. https://doi.org/10.1088/2058-6272/aadd44]. In addition, as a phase work, we reported the original idea about the intensity of the HFIL in paper [*Altitude and intensity characteristics of parametric instability excited by an HF pump wave near the fifth electron harmonic, Plasma Sci. Technol., 19(12), 2017.*]

(6) **a systematic variation in the altitude of the HFPL as a function of pump frequency**, namely, the altitude of the HFPL in the HB is lower than that in the GB, as shown in **Fig 6.** This result was submitted ANGEO with number angeo-2019-23, namely, the reviewed paper.

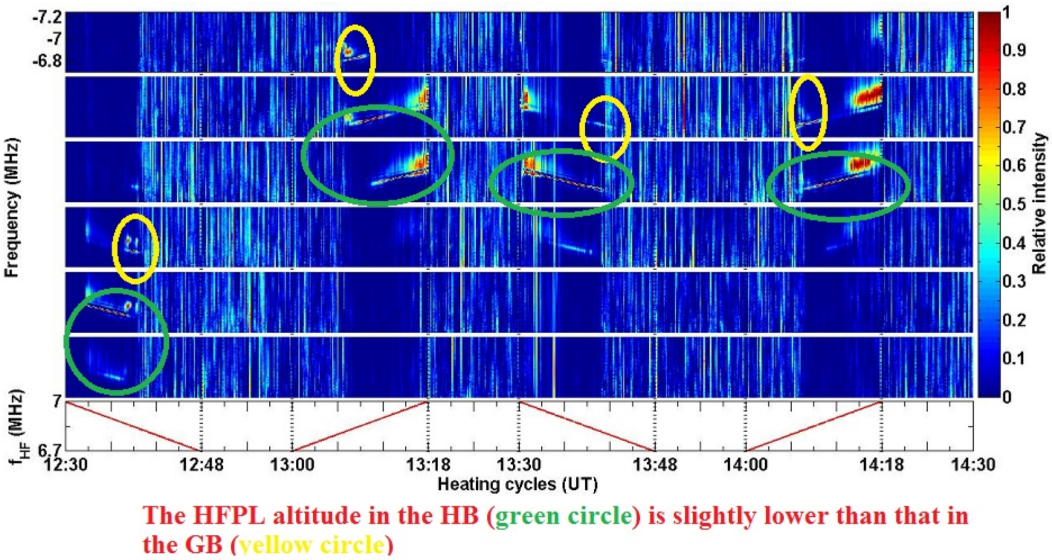


Fig 6. a systematic variation in the altitude of the HFPL as a function of pump frequency

As those statements above mentioned, using those observations (data) obtained in the interval of 12.30 – 14.30 UT on 11 March 2014, **six** interesting phenomenon (scientific questions) were studied and published respectively, implying that **although the same observations (data or figures) were used in those published papers, but the focused question in those published papers is very different from each other**. Thus, this manuscript (angeo-2019-23) does **not repeat the study results** which have been published by authors, but only **repeats those radar observations**. Indeed, the heating results at third gyroharmonic have been discussed by Honary et al. (JGR 100, 21489, 1995), which should be cited.

2. In addition, the Discussion is confusing and appears logically inconsistent. For example, the paragraph lines 161-177 concerns a logic that is applicable for a constant Langmuir wave frequency, that is constant pump frequency. But in the experiments the pump frequency is changed. Both the pump frequency and T_e influence the height at which Langmuir waves are detected by the radar. These two should be kept separate, not mixed together. Taken together, therefore, I cannot recommend publication of this manuscript.

This can be due to my poor English. I would like to make some clarity.

When the enhanced Langmuir wave travels in a non-uniform and stationary ionosphere, k_{L} may change, whereas ω_{L} will not change. That is, k_{L} should depend on ω_{pe} and T_{e} on the traveling path of the enhanced Langmuir wave. This implies that at a particular altitude, k_{L} will satisfies the Bragg condition, namely, $k_{\mathrm{L}} = 2k_{\mathrm{r}}$, and the enhanced Langmuir wave should be observed by radar, where k_{r} is the wave number of radar.

Although the fact is that ω_{LHB} is slightly larger than ω_{LGB}, here we consider the enhanced Langmuir wave at single frequency ω_{L} for the sake of simplicity, where ω_{LHB} and ω_{LGB} are respectively the frequency of the enhanced Langmuir wave in the HB and GB.

In the GB, the enhanced Langmuir wave at frequency ω_{L} should be observed at an altitude h_{GB} where the Bragg condition is satisfied, namely, $2k_{\mathrm{r}} = k_{\mathrm{L}} = \sqrt{\frac{\left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peGB}}^2\right) m_{\mathrm{e}}}{\gamma \mathrm{K_B} T_{\mathrm{eGB}}}}$, where ω_{peGB} is Langmuir frequency at altitude h_{GB}.

In the HB, the enhanced Langmuir wave at frequency ω_{L} should be observed at an altitude h_{HB} where the Bragg condition is satisfied, namely, $2k_{\mathrm{r}} = k_{\mathrm{L}} = \sqrt{\frac{\left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peHB}}^2\right) m_{\mathrm{e}}}{\gamma \mathrm{K_B} T_{\mathrm{eHB}}}}$, where ω_{peHB} is Langmuir frequency at altitude h_{HB}.

Thus, $\sqrt{\frac{\left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peGB}}^2\right) m_{\mathrm{e}}}{\gamma \mathrm{K_B} T_{\mathrm{eGB}}}} = \sqrt{\frac{\left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peHB}}^2\right) m_{\mathrm{e}}}{\gamma \mathrm{K_B} T_{\mathrm{eHB}}}}$ should be obtained. In further, $\frac{\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peGB}}^2}{T_{\mathrm{eGB}}} = \frac{\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peHB}}^2}{T_{\mathrm{eHB}}}$ is obtained. Due to $T_{\mathrm{eGB}} < T_{\mathrm{eHB}}$, then $\left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peGB}}^2\right) < \left(\omega_{\mathrm{L}}^2 - \omega_{\mathrm{peHB}}^2\right)$. In further, $\omega_{\mathrm{peGB}}^2 > \omega_{\mathrm{peHB}}^2$ is obtained. Thus, Due to the monotonous profile of ω_{pe} below the ionospheric peak, $h_{\mathrm{GB}} > h_{\mathrm{HB}}$ is obtained.

In other word, with regard to the enhanced Langmuir wave at frequency ω_{L}, considering the dispersion relation $\omega_{\mathrm{L}}^2 = \omega_{\mathrm{pe}}^2 + \gamma \frac{\mathrm{K_B} T_{\mathrm{e}}}{m_{\mathrm{e}}} k_{\mathrm{L}}^2$, ω_{pe} and T_{e} have to compensate each other so that $k_{\mathrm{L}} = 2k_{\mathrm{r}}$, and frequency ω_{L} keeps unchanged. That is, when T_{e} is small, ω_{pe} should be large, namely, the observing altitude (the corresponding altitude of ω_{pe}) is high. When T_{e} is large, ω_{pe} should be small, namely, the observing altitude (the corresponding altitude of ω_{pe}) is low.

3. We sincerely request the reviewer to re-consider the comment and conclusion please. If so, we will make some modification and clarity.

Indeed, The descents of the HFPL and HFIL altitudes at EISCAT UHF, VHF and MUIR were frequently observed, which were attributed to the change in the profile of electron density [*Djuth et al.* 1994; *Kosch et al*., 2004; *Dhillon et al*., 2005; *Ashrafi et al.*, 2006; 2007] or the artificial descending layers [*Streltsov et al*., 2018].

In this paper, however, we suggested an alternative explanation for the descents of the HFPL, namely, the descents of the HFPL may be due to the enhanced electron temperature on the traveling path of the enhanced Langmuir wave rather than the change in the profile of electron density. We are trying to express that this paper should be new and meaningful.