

## ***Interactive comment on “Variation in altitude of high-frequency enhanced plasma line by the pump near the 5th electron gyro-harmonic” by Jun Wu et al.***

### **Anonymous Referee #1**

Received and published: 12 April 2019

The manuscript describes experimental results from EISCAT UHF radar observations in the course of HF pumping experiment at Tromsø near the fifth electron gyrofrequency on 11 March 2014 from 12.30 – 14.30 UT. The particular attention is paid to the observing altitude of the HF-enhanced plasma lines excited by an O mode pump in the course of the frequency stepping through the fifth electron gyrofrequency. Authors concluded that EISCAT UHF radar observations have demonstrated that the enhanced electron temperature plays a decisive role in the descent in the HFPL altitude. This manuscript repeats the results which have been yet published by authors for the same experiment on 11 March 2014 and for the same time interval from 12.30 – 14.30 UT in following articles:

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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. 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 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, M T Rietveld, I Haggstrom, H. Zhao and Z. Xu, Altitude and intensity characteristics of parametric instability excited by an HF pump wave near the fifth electron harmonic, *Plasma Sci. Technol.*, 19(12), 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.

Note, that the only experiment on 11 March 2014 is not unique itself. There were a lot of other frequency stepping experiments near the electron gyroharmonics at EISCAT. For a example, Borisova et al (*Radiophys. & Quantum Electron.*, 2016, 58, 8, 561-585) has described and analyzed a series of EISCAT O-mode HF pump frequency stepping experiments near the fifth electron gyroharmonic carried out on 22, 23, 25 and 26 October 2013, when the features and behaviors of HF-enhanced ion and plasma lines from EISCAT UHF radar observations were considered in the combination with the artificial field-aligned irregularities from the CUTLASS (SuperDARN) observations and spectral features of the stimulated electromagnetic emission measurements.

The important comment is also that the Discussion section, based on the articles by Stubbe et al., 1992; Djuth et al., 1994, is appropriate only for the vertical incident angles. However, the experiment on 14 March 2014 was conducted under HF pumping towards the magnetic zenith. O-mode HF pump waves at the magnetic zenith reflect below the standard reflection layer at vertical incident angles (see Mishin et al., *JGR*,

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2004, V.109, A02305; Ann. Geophys., 2005, 23, p.47-53 and Fig.21 from Gurevich, 2007). Moreover, at high pump frequencies near the 5th electron gyro-harmonic ( $f_H \sim 5f_{ce}$ ) the pump wave is reflected near the upper hybrid resonance altitude. Therefore, the careful estimations of the reflection altitudes at MZ pumping are necessary.

It should also be noted that the analysis of changes in the excited height of PDI and OTSI instabilities, taking into account the dispersion relations, is carried out under the assumption that the parameters of the ionospheric plasma are monotonous. However the spatial changes of the electron density and temperature versus  $f_H$  (the time of heating cycles) are more complicated that are not taken into account in the analysis of pump frequency variations around the fifth electron gyro-harmonic.

Conclusion. The manuscript adds nothing to the results, which were already published by authors. The Discussion section is not correct for the conditions of the experiment on 14 March 2014, when HF pumping was produced towards the magnetic zenith and not considered the behavior and features of the parameters of the ionosphere near electronic gyroresonances.. I cannot recommend the manuscript for the publication.

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Interactive comment on Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2019-23>, 2019.