

Dear Editor and Reviewer!

Thank you very much for the comments, which lead to the improvement of the quality of the paper, again!

The following is improved in accordance with your comments revealing the new improvements in the text by blue and in the formulas - by red colors; the revealing the improvements done on the previous stages of the paper's revision using the red color is saved in the present version of the paper as well.

Editor's comment:

(1) There appeared some unclearness in the text. Most probably, some of them are due to conversion to pdf. format, e.g. "Ltym hf,jnf. C jndtnjv htwtyptynfv b ghb `njv enjxyz. B ntrcn" (lines 68-69)

Now it is written in **P2 L68-69**:

This allows to determine the leakage modes and to interpret not only ground-based, but also satellite measurements of the VLF beam characteristics.

Referee's comments:

(2) Line 73 remove a in "adequately a data"

Now it is written in **P3 L74**:

...adequately data...

(3) Line 430 Zc11 does not exist

Now it is written in **P17 L436**:

... Z_{011} =...

(4) There is a problem with the legend of Figure 3. We do not know where are the real and the imaginary parts of the components.

Now it is written in **P18 L444-445**:

(b) – (g) The real (corresponding lines with the values denoted by one prime) and imaginary (corresponding lines with the values denoted by two primes) parts of the components ε_1 , ε_3 , ε_h , general and detailed views.

(5) Line 443 -5 to be exponent

Now it is written in **P18 L453**:

... $3 \cdot 10^{-5}$ Gs...

(6) In Figure 6, 6b looks like 6f please check

Yes, thank you! Fig. 6b is now replaced by the proper one, **P20 L482**

(7) Line 531 please check because it seems not related to fig 8d

No, this line (now: **P22 L544-545**) does relate to Fig. 8d; curves 1-4 at this Figure correspond to the different values of θ (see **P22 L528, 533-534**).

(8) Line 536 meaning of f here ? f is already used as the frequency !!

Thank you! Yes, now the non-dimensional coefficient " f " is replaced by " f_{00} " in formula (35) (**P23 L549**); relations with " f_{00} " included in (**P23 L557; P23 L558**).

(9) However I recommend to the authors to carefully read again their paper. I have seen some problems but I am not sure that I have seen all the small points concerning for example the equations and the figures

Yes, we have rechecked the text of the paper, figures, formulas. As a result, the following additional improvements have been done.

- The reference concerning the properties of E-region is added: in the text - (Guglielmi and Pokhotelov, 1996), **P13 L332**; in the list of references- in **P33 L 853**

- The determination of β_{33} is rewritten more accurately, namely the previous formula $\beta_{33} = \varepsilon(z=0)^{-1}$ is replaced now by $\beta_{33} = \varepsilon^{-1}(z=0)$ in **P 15 L367; in the same line**, in the formulas for the components of the impedance the index “0” missed previously, namely $Z_{012} = Z_{021} = 0$

- The misprinting in second formula from (31b) is improved, namely the previous formula
$$\frac{i}{\varepsilon(z=0)k_0} \frac{\partial H_y}{\partial z} + \frac{i}{k_0} Z_{0E} H_y = 0$$
 (containing the second term with a wrong dimensionality) is replaced now by
$$\frac{i}{\varepsilon(z=0)k_0} \frac{\partial H_y}{\partial z} + Z_{0E} H_y = 0$$
, see **P 15 L 368**.

- The phrase “...for the magnetic field maximum value (Fig. e) is $3 \cdot 10^{-5}$ Gs \approx 3 nT \approx 10 mV/cm.” is replaced by “for the magnetic field maximum value (Fig. e) is $3 \cdot 10^{-5}$ Gs \approx 3 nT.”, see **P18 L453**.

- Axes labels in Fig. 4 and Fig. 6 are corrected to be clearly visible

- The references to the books, from which ionospheric data has been taken, are added in in the text: **The parameters of the ionosphere used for modeling are taken from (Al'pert 1972; Alperovich and Fedorov 2007; Kelley 2009; Schunk and Nagy, 2010; Jursa 1985) -**

In **P 17 L424-425** in the text of the paper and in (**P32 L798; P31 L796-797; P34 L869; P36 L943; P34 L868**) – in the list of references.

- The acknowledgements concerning OA, JB, VF are improved/detalized – in **P25 L784-788**

- The caption of the Figure 11 is improved with adding the proper license of the paper Rozhnoi et al. (2015) mentioned in this caption, see **P25 L 603-604**

- Fig. 12b is rebuilt, to illustrate more clearly the main information presented in this Figure, see **P25 L605**.

- The Sections AUTHOR CONTRIBUTION, COMPETING INTERESTS, DATA AVAILABILITY are added, see **P30-31 L759-781**

- The set of other minor clarifications: improvements of misprintings and small stylistic and grammar improvements, not described here in details, have been added as well.