Nonlin. Processes Geophys. Discuss.,
https://doi.org/10.5194/npg-2019-56-AC2, 2020

Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Nonlinear vortex solution for perturbations in the Earth's Ionosphere" *by* Miroslava Vukcevic and Luka Č. Popović

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Received and published: 19 January 2020

We are grateful to all comments given by Referee. We hope that our answers will improve our manuscript and make it more understandable. 1. "This might be a useful theoretical practice, however, it is unclear how the study can be applied to address outstanding science questions in ionospheric physics." Answer: Study of electromagnetic wave propagation, linear wave theory, gives the opportunity to identify and detect frequencies of possible waves propagating within ionosphere (gravity and acoustic modes) but linearization procedure mimic the importance of nonlinear effects on the wave dynamics. The best example of neglected nonlinear effects is tsunami wave, wave with constant amplitude and huge constant velocity traveling with no dissipation at all, as long as the condition of balance between nonlinearity and dispersion is as-

sured. Implementation or study of the dynamics using linear waves can mislead to the conclusion that such waves would break down and rise up in shorter time scale, due to dispersive properties of the medium. If the medium is dispersive and nonlinearity can balance it, then it can break down after traveling long distance, gaining a huge amount of energy that is realized suddenly after the balance is broken. If predicted earlier, it can safe either human lives or electric devices. Simple monitoring of these structures gives an opportunity for fast prediction and reaction of mentioned events that could have influence on humans. In our research, we have identified parameter for dispersion and parameter for nonlinearity; following change in their values it can provide fast detection of any anomaly that can be subject of different drivers/excitations/interaction of the medium. 2. "Are there any observations of solitary structures in the ionosphere? Observational evidence would be good to mention." Answer: We have cited few observed evidences for the obtained solution: Hallinan T. J., & Davis T. N. 1970, Planet. Space Sci. 18, 1735 for different dynamical morphologies of the aurora. We can provide some more references regarding this topic as: D. A. Gurnett, R. L. Huff, J. D. Menietti, J. L. Burch, J. D. Winningham and S. D. Shawhan 1984, J. Geophys. Res. 89, A10, 8971, P. R. Fagundes, V. G. Pillat, M. J. A. Bolzan, Y. Sahai, F. Becker-Guedes, J. R. Abalde and S. L. Aranha 2005, J. Geophys. Res. 12302, A10, 8971. Lin C. H., Wang W., Hagan M. E., Hsiao C. C., Immel T. J., Hsu M. L., Liu J. Y., Paxton L. J., Fang T. W., & Liu C. H. 2007, Geophys. Res. Lett. 34, L11112 and Huang C. Y., Marcos F. A., Roddy P. A., Hairston M. R., Coley W. R., Roth C., Bruinsma S., Hunton D. E. 2009, Geophys. Res. Lett. 36, L00C04 Both references discuss the anomaly in density either electron or neutral; our solution obtained for the potential as bright soliton (enhanced), means that the density is decreasing within the soliton size since the particles are trapped in that potential. If the potential is dark soliton, then it can explain enhanced density within the same region. As far as simulations are concerned, we have cited the paper that clearly provide evidence for the structures predicted by our solution: Maruyama, N., Y.-Y. Sun, P. G. Richards, J. Middlecoff, T.-W. Fang, T. J. Fuller-Rowell, R. A. Akmaev, J.-Y. Liu, & C. Valladares, 2016, Geophys. Res. Lett. 43 (6), 2429 3. "In addition, major

drivers of the ionosphere, including the solar irradiance, space weather conditions, and lower atmospheric forcing are not considered in the study at all. “ Answer: The aim of the paper is not to discuss the trigger of the ionospheric disturbances, but rather to propose the solution for the possible structure as a result of that disturbance. It is not always possible to create such structure. The aim of the paper is to re-investigate the condition for that creation. It turns out that assumption of the constant unperturbed thickness of the layer, used in number of papers discussed the ionosphere dynamics using wave phenomena, is not adjusted. 4. “The electrodynamical effect in the ionosphere is not included either.” Answer: We have solved self-consistently fluid equations and Maxwell’s equation for somewhat simplified case, using electromagnetic filed. Effects of electric filed enter the equation of motion via conductivity, due to collisions of neutrals and charged particles. We have already suggested to add appendix with derivation of ExB drift/ponderomotive force acting on the fluid. We hope that Referee will be satisfied by answers. Please, do not hesitate to ask if there are any further questions.

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