Nonlin. Processes Geophys. Discuss.,
https://doi.org/10.5194/npg-2017-33-RC2, 2017

Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Satellite drag effects due to uplifted oxygen neutrals during super magnetic storms" *by* Gurbax S. Lakhina and Bruce T. Tsurutani

Y. Narita (Referee)

yasuhito.narita@oeaw.ac.at

Received and published: 8 September 2017

The manuscript develops a simplified model for the oxygen uplift from the low-altitude ionosphere to the higher altitude caused by the enhanced E x B drift effect during the extreme or major geomagnetic storm time, and applies the oxygen fluxes to predicting the satellite drag by taking the Carrington super-magnetic storm event as an example.

The manuscript is a beautiful application involving the space science (the Sun-Earth relation), the physics of the ionosphere, and the engineering aspect (satellite drag estimate). The model for the oxygen uplift (section 2) is rather simple, but nevertheless contains the essence of the physical process (uplift flow estimate, drag force between

plasma and neutral, scale height, and continuity). The model is developed for the linear treatment of the uplift, but the authors address what effects need to be considered when upgrading into the nonlinear treatment.

The authors apply the oxygen density profile (from section 2) to the model of the satellite drag force (Equation 6, section 3), and find that the drag force can significantly vary from a lower to a higher altitude by a factor of about 40. The authors also find that the electrostatic drag force (Coulomb effect) dominates over that of the neutral gas at higher altitudes above 750 km.

The manuscript reads well. The logic and the calculations are easy to follow. And the study is concise with a clear message to the audience. The manuscript will also serve as a beautiful example of writing a paper for the young students. I enjoyed reading the manuscript. I have only minor comments in a hope of improving the quality of the manuscript a bit (the authors may disagree). In any case, I recommend the manuscript for a prompt publication.

page 2, line 37. "GPS" appears for the first time in the main text. I propose to rewrite into "GPS (Global Positioning System)" such that the readers can continue reading the paper without being disturbed by the acronym.

page 4, line 91. I wonder how the reference altitude (340 km) was chosen. Can the authors say if it is conventional or maybe if it is from a computational reason?

page 4, line 107 to page 5, line 109. Should the advection of the O-atom flow (U dot nabla U) be included for the nonlinear treatment, too? Turbulence physicists might find the advection term as interesting as the other effects.

page 5, line 127. "adsorbed" should read "absorbed".

page 6, line 140. As a reader, I prefer to see "we give the estimates of..." rather than "we have given the estimates..." because the discussion sounds on-going. But the authors can decide.

page 6, line 164. It is better to write "EXB" as \mathbf{E} \times \mathbf{B} coherently in the text.

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2017-33, 2017.