Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2020-42-RC2, 2020

Annales Geophysicae Discussions

Interactive comment on "Lower thermosphere – ionosphere (LTI) quantities: Current status of measuring techniques and models" *by* Minna Palmroth et al.

Anonymous Referee #2

Received and published: 28 September 2020

The article "Lower thermosphere - ionosphere (LTI) quantities: Current status of measuring techniques and models" by M. Palmroth et al. constitutes a large review of the complex physical environment of Earth Lower thermosphere and ionosphere, covering theoretical considerations, experimental techniques and models. The term ignorosphere has been used to indicate this part of the Earth outer space, because of the difficulties of establishing measurement systems that could monitor its physical and chemical parameters on a continuous base globally. Therefore there are still many open scientific questions, that the proposed Daedalus mission could help answering from in-situ measurements. In the Lower thermosphere the forcings from above (principally solar radiation and particle precipitations) deposit large amounts of energy and

the forcings from below (principally through tides and waves activity) can significantly affect the physico-chemical processes of both thermosphere and ionosphere. There are such a large varieties of phenomena taking place in this region, that it is not possible to resume all of them in a single review paper, and this paper covers most of them, also pointing out to some phenomena of interest also outside the scientific community, with recently discovered auroral activities. In the article various measuring techniques are described, covering not only thew Lower Thermosphere region, but the thermosphere and ionosphere as a whole, with a specific focus to point out the current limitations of this lower altitudinal range and expressing the need for new satellite missions devoted to collect in-situ measurements of the various quantities involved: particles, densities, winds, magnetic fields. . . Despite the complexity of the topics covered, the article is well organised and refers to recent advances in all the disciplines involved, both from the theoretical and experimental point of view.

The article can be accepted for publication.

The following remarks are suggestions for minor corrections that could be implemented for improving the overall quality of the manuscript.

Reading the manuscript it clearly appears that it has been written by multiple authors: a few definitions are expressed a couple of times, but without significant overlap.

Acronyms are not always defined at first use, sometimes they are defined multiple times e.g. (list non exhaustive): WACCM on page 4, 8, 16 and 19 for WACCM-X, which was already defined on page 4 GPS used on page 19, defined on page 20. GNSS defined on page 39, used on page 19, 20. IPIM defined on page 16 and 19 SuperDARN defined on page 31, used first time on page 23. TomoScand is not defined on page 40.

Some figures show ionospheric parameters computed using the International Reference Ionosphere model (IRI). The citation provided and the model shown are not the latest version, which was released in 2016, IRI-2016. The profiles shown might be identical in the IRI-2016, but the latest publications of this model should be cited (e.g. on page 4 and 17): Bilitza, D., D. Altadill, V. Truhlik, V. Shubin, I. Galkin, B. Reinisch, and X. Huang (2017), International Reference Ionosphere 2016: from ionospheric climate to real-time weather predictions, Space Weather, 15, 418–429, doi:10.1002/2016SW001593.

I think that captions of figures 1 and 2 should be improved. it is not clear if these two figures show the same altitude range: figure 1 is representing an isobaric surface, while figure 2 a fixed geometrical altitude range. In the text it is indicate that WACCM-X has been extended up to about 500 km, but an explicit indication in the figure caption would be helpful. In the representation of the quantities shown in figure 1, there are no axes to allow the reader to understand where the various panel's quantities are located in altitude.

On page 11 line 286, the need of a sufficient horizontal resolution and time resolution at low latitudes is expressed, but it is not quantified. I suggest to provide some values that could be used as guidelines for reaching specific scientific goals. This same remark is valid for other conclusions of this article, where no explicit values are indicated.

Figure 4 shows combined results from two different empirical climatological models: NRLMSISE-00 for the neutrals and IRI for the ions. it shows that for some species (N and O) the scale heights of the neutral and its corresponding ion are extremely different. It turns out that in the upper part of the plot the density differences can be of many orders of magnitude. This points out clearly the limitations of these models and an indication that in-situ measurements of both neutrals and ions are necessary.

Page 38, line 1069: following earthquakes, even tsunamis are source of gravity waves observed in the ionosphere (e.g. Makela, J. J., P. Lognonné, H. Hébert, T. Gehrels, L. Rolland, S. Allgeyer, A. Kherani, G. Occhipinti, E. Astafyeva, P. Coïsson, A. Loevenbruck, E. Clévédé, M. C. Kelley, and J. Lamouroux (2011), Imaging and modeling the ionospheric airglow response over Hawaii to the tsunami generated by the Tohoku earthquake of 11 March 2011, Geophys. Res. Lett., 38(13), L00G02). On line 1065

the focus of this part has been put on gravity waves, but some of the phenomena highlighted produce mostly acoustic waves. It is stated correctly that TIDs are observed, which encompass both kind of waves. I think that the unaware reader might not perceive their differences.

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