Equatorial plasmaspheric parameters obtained from Jicamarca ISR data

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Abstract

The layers of the Earth's atmosphere that immediately envelop the ionosphere, the plasmasphere and the magnetosphere, act as a coupling medium between solar radiation and the ionosphere and are important for a better understanding of the relationship between the Earth's atmosphere, space weather and solar dynamics.
Obtaining ISR data from very high altitudes has been and still remains a challenge due to low SNR and transmitter power constraints.
In the current poster, we present curves of ionospheric parameters that span up to 2100km well into the plasmasphere.
In addition, we present an analysis of three different ionospheric models (SAMI2, SAMI3 and SAMI2-PE) and propose some improvements.

I. Introduction

The plasmasphere is that region of the atmosphere which extends immediately after the ionosphere. It consists mainly of cold plasma in the range of 1-2 *eV* trapped by the earth's geomagnetic field.
The study of the plasmasphere is an extremely important area of atmospheric research as it plays a crucial role in radiation belt dynamics [1] but is rather still poorly understood.
In the present study, we take a two pronged approach to deepening our understanding of this area of the upper atmosphere: high altitude experiments and ionospheric models.
Experimental data is analyzed using full profile analysis, which is an optimization algorithm for extracting plasma parameters from sampled data.
Low latitude ionospheric models SAMI2, SAMI2-PE and SAMI3 that analyze the evolution of several plasma species, are compared.

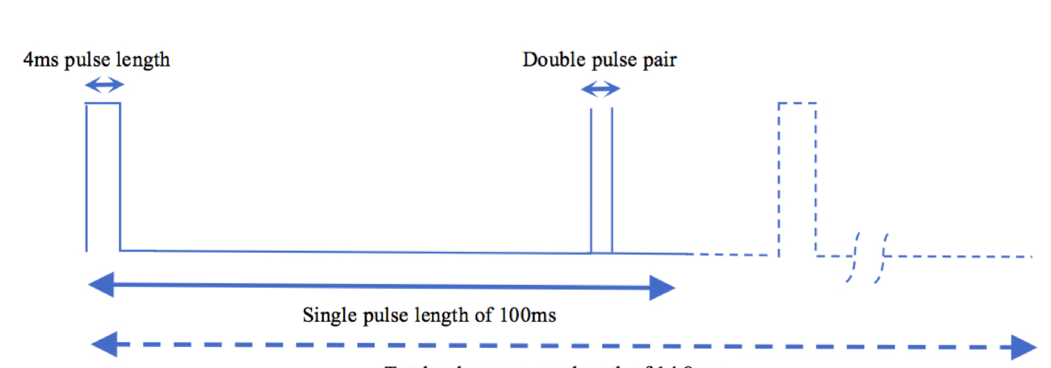

Figure 1 – 4ms long pulse sequence

II. Results from High Altitude Experiments

The full profile algorithm was modified to incorporate two long pulse lengths (2ms & 4ms) allowing higher altitudes to be reached. In the hybrid experiment conducted on July 12 2017, profiles up to 2100km were generated. See Fig 2.
The transmitted pulse used was composed of 2ms and 4ms long pulses juxtaposed with a short double pulse pair (Fig 1).
The inclusion of 4ms pulse lengths was a consequence of the fact that longer pulse lengths provide more power and better SNR ratios at higher altitudes.
Different pulse configurations are being tested at this time to further improve the SNR.

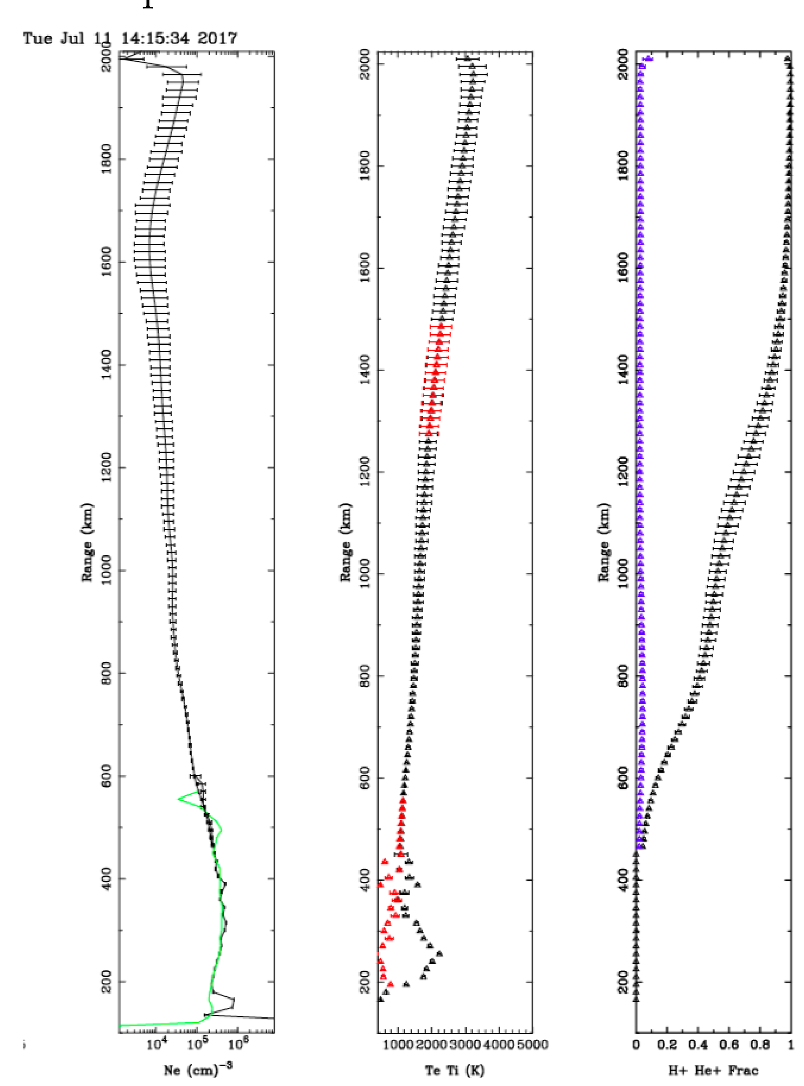

Figure 2 – Ne, Te, Ti, and H+ and He+ fractions up to 2100km from a hybrid pulse experiment on July 12 2017

III. SAMI Model Comparisons

On the right we show RTI plots for Ne and Te generated from the three ionospheric models (SAMI2, SAMI2-PE and SAMI3) and Jicamarca data for the period of March 25, 2009. Our objective is to propose an enhanced model that will include the Te dip at noon, the Te glow at pre-sunrise and post-sunset, and possess good accuracy for high altitudes.

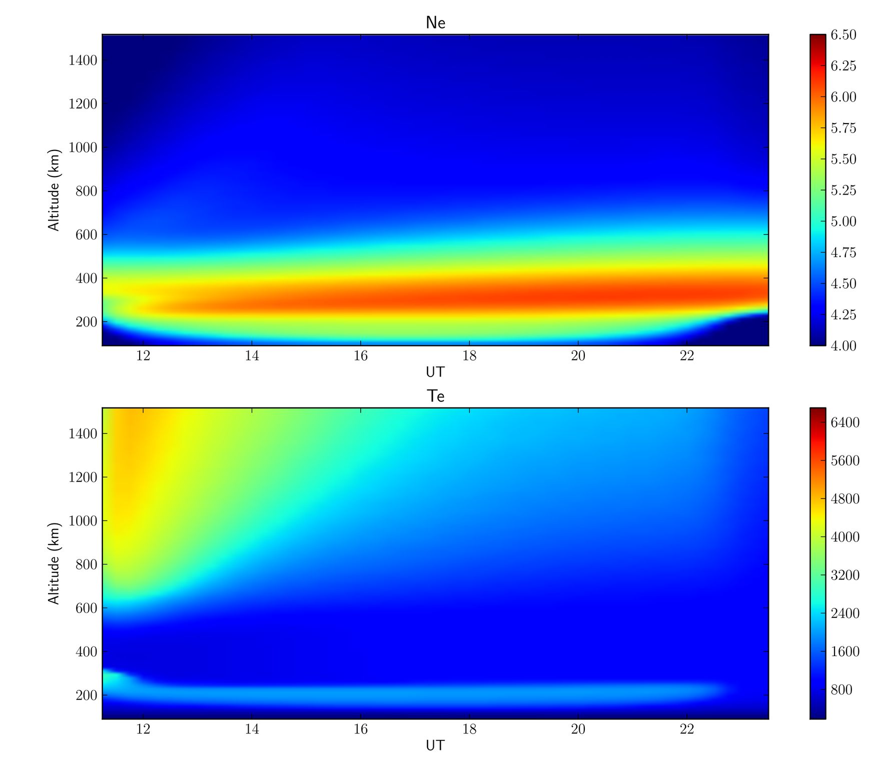

Figure 3 – Ne and Te modeled by SAMI2 over Jicamarca on March 25 2009

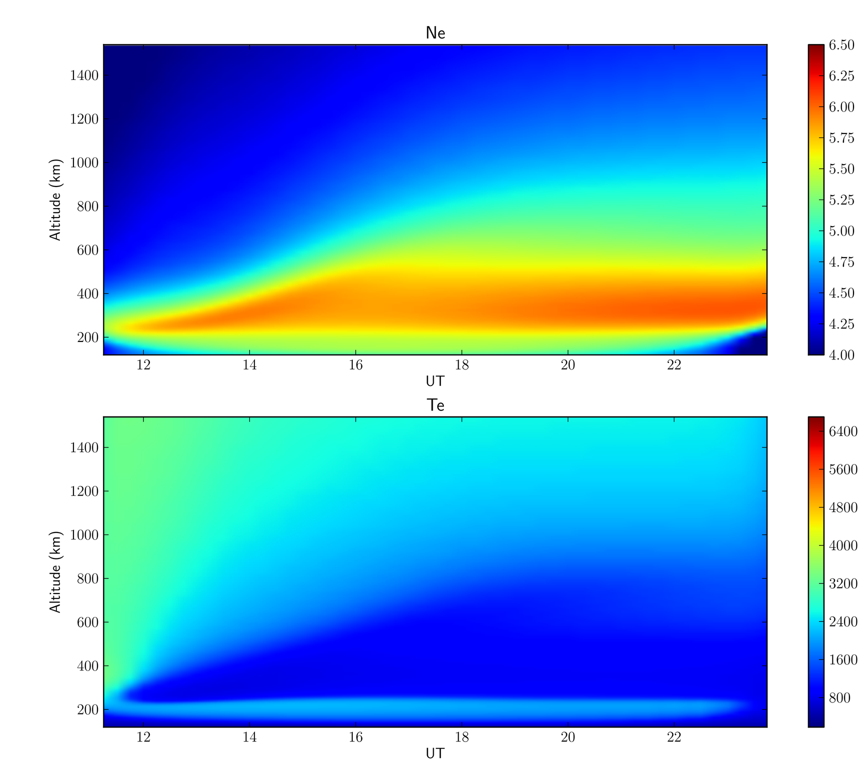

Figure 4 – Ne and Te modeled by SAMI2-PE over Jicamarca on March 25 2009

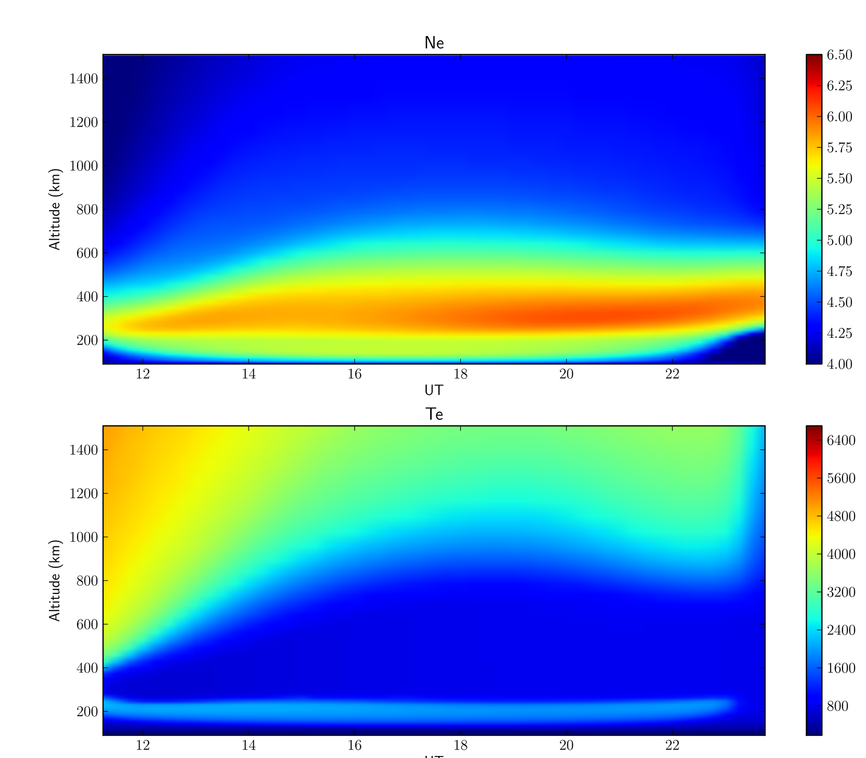

Figure 5 – Ne and Te modeled by SAMI3 over Jicamarca on March 25 2009

The important differences between the models are:
SAMI2: 2D model. ExB drifts solved using Fejer/Scherliess model[2].
SAMI3: 3D model. Includes potential solver for electric field in ExB drift.
SAMI2-PE: Enhanced version of SAMI2. Includes photoelectron transport model.

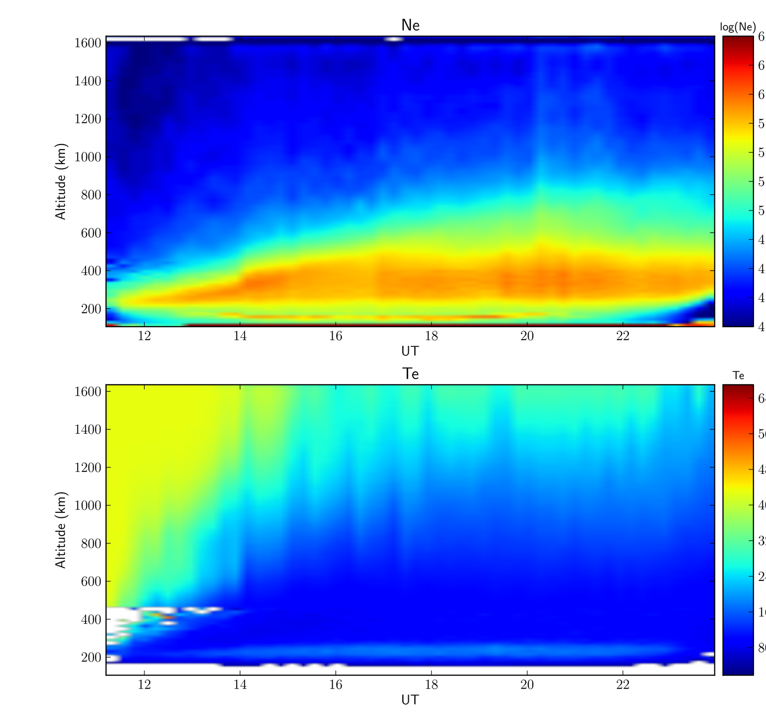

Figure 6 – ISR Data from Jicamarca on March 25 2009

IV. Analysis and Discussion

An observation of the Ne plots reveals that SAMI2-PE shows a configuration closest to data. SAMI3 trails in second.
A comparison of the Te plots shows that both SAMI3 and SAMI2-PE do a reasonable job of approximating the shape of the Te variations. Only SAMI3 hints at a drop of temperatures at noon.
Both SAMI3 and SAMI2-PE reveal high Te after sunset, however only SAMI3 shows significantly distinct Te values post sunset consistent with data.
In conclusion, SAMI3 and SAMI2-PE show significant improvements of different aspects of SAMI2 and should be combined into a new model.
The new model needs to be evaluated at pre-sunrise and in regards to variation of sunset time with altitude.

Conclusions

- A new pulse configuration will be explored at Jicamarca to improve SNR and probe at even higher altitudes
- A new model (SAMI3-PE) will be developed to resolve the shortcomings of the other models and improve high altitude accuracy.

References

[1] J. Huba and J. Krall. Modeling the plasmasphere with SAMI3, *Geophys. Res. Lett.*, *40*, 6-10, 2013.

[2] J. D. Huba and G. Joyce., Sami2 is Another Model of the Ionosphere(SAMI2): A new low-latitude ionosphere model, *Journal of Geophysical Research,*, *105*, A10,035-23,053, 2000.