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High Altitude ISR Experiments at Jicamarca in Extremely Low Solar Flux Conditions

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We present recent data and advances in high altitude ISR experiments at Jicamarca that allow more accurate estimates of ionospheric parameters of the equatorial topside ionosphere and lower plasmasphere during extremely solar flux conditions, in particular the deep solar minimum of 2019-2020.

Jicamarca's unique combination of low radar frequency, high transmitter power, along with the hybrid long pulse experiment design make it especially suited for probing high altitudes of up to 2000 km in low solar flux conditions, and higher otherwise. This is a crucial step in complimenting data from satellites, verifying models, and allowing us to build a more comprehensive understanding of the equatorial upper atmosphere.

Ionospheric parameter altitude profiles (N_e, T_e, T_i and O^+, H^+ , He^+ ion composition) that span heights of up to 2000 km will be presented. Along with these, we will elaborate on the experimental setup (hybrid long pulse experiment) and inverse methods (full profile analysis) with which we are able to extract the information above. Full profile analysis is the signal processing and optimization algorithm used for transforming the receiver voltage samples into parameter profiles.

Advances in the data processing techniques will be explained, which include improved initial guess estimation using stochastic global optimizers with a higher number of parameters, loosely constraining Te/Ti using DMSP data, the use of more advanced clutter elimination techniques, improved noise filtering algorithms and incorporation of an updated IGRF model (2019-2024) that reflects the recent large scale changes to the magnetic field.

Comparisons between newly updated models (SAMI2 and SAMI2-PE) outputs to the above experimental data have also prompted important revisions to the models. The greatest source of discrepancies are between sunrise electron and ion temperatures which are higher in the data than in the model, a consistent mid-afternoon drop seen in the data that exceeds that which is observed in the model, and a curious increase in Te/Ti seen in the data around 3am LT, also observed in satellite data but not present in the models. Some of our ongoing research in this area will be discussed, such as a reassessment of the heating sources in the models, and the investigation into the possibility of contribution of geocoronal scattered light to the temperatures.

References

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