

D-region electron density during sunset: a comparison between measurement and model

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The D-region is the only part of the ionosphere where the existence of negative charge carriers apart from electrons is possible. Here, a rather complex ion chemistry gives rise to a diverse population of negatively and positively ions, cluster ions as well as negatively and positively charged nanometer-sized particles. Investigations of the electron density during sunset and sunrise, i.e., the turning off and on the most relevant ionization source, reveal hardly measured but important aspects of the ionosphere and background atmosphere.

This work analyses electron density measurements done with the Arecibo incoherent scatter radar (ISR) located in Puerto Rico. Observations were carried out from August 28. until 31. 2016 and from 16:00 - 20:00 local time, which corresponds to sunset conditions from 60 to 110 Solar zenith angle. By applying a super-imposed epoch analysis we are able to estimate the natural variability of the quiet time D-region. For interpretation of the measured electron densities, we apply the Sodankylä Ion and Neutral Chemistry model (SIC). This model incorporates the complex reaction scheme of the D-region and Neutral background atmosphere and its interlink through ion-neutral reactions.

The analysis of this dataset aims at verifying the importance of meteoric smoke particles in the D-region chemistry, especially during night time. Indeed, signatures of MSP relevance, as expected from earlier model approaches, are visible in an altitude region between 80 and 85 km. However, the conclusions remain to some extent speculation, as the detection limit of the ISR is reached at relevant Solar zenith angles. Another analysis approach is the investigation of nitric oxide (NO) profile during the day, as motivated from satellite measurement indicating different NO levels during sunset and sunrise. Our ISR electron density measurements enable the deduction of a possible diurnal variation of the D-region nitric oxide concentration.