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Investigation of Altitude and Solar Cycle Variation of DDM Occurrence Using Ionosonde Observations

The diurnal variation of plasma density in the ionosphere is largely characterized by a single peak around local noon. However, diurnal double maxima (DDM) is sometimes observed when two distinct peaks and one valley in plasma density appear during the local daytime. Understanding DDM structures is essential for studying ionospheric dynamics and their key drivers, including neutral winds, E ×B drift, and solar irradiation, as these variations impact radio wave propagation and space weather forecasting. This study investigates DDM occurrences using ionosonde observations from stations in Hermanus (34.4◦S, 19.2◦E, magnetic latitude: 42.08◦S) and Grahamstown (33.3◦S, 26.5◦E, magnetic latitude: 41.06◦S) during solar cycle 24 (2008–2019). A robust automated algorithm was developed to detect DDMs based on the presence of two fully formed peaks separated by a depletion (valley), all occurring between local sunrise and sunset. The algorithm established the criteria using a minimum peak-to-valley ratio of at least 6% to ensure significant peak prominence, a minimum peak-to-peak interval of 40 minutes to capture the time difference between two peaks, and an extra peak prominence threshold not exceeding 5% to filter out additional peaks. These thresholds ensure that only well-defined DDM structures are identified. The method was validated through visual inspection, achieving a detection accuracy of 97%. Using this approach, we identified 1,532 and 1,270 DDM events at Hermanus and Grahamstown from a total of 3,534 and 2,835 observation days, respectively, over the whole solar cycle. This translated to an occurrence rate of 43% at Hermanus and 45% at Grahamstown. We will explore statistical trends in terms of seasonal and solar cycle variations for each ionosonde station. Comparing and contrasting the trends between the stations may provide indications about possible mechanisms influencing DDM development. Furthermore, we will explore whether there are DDMs that are common between the two stations, as this may indicate the scale size and/or propagation of these events.

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