Variation of α-Chapman scale height at an African equatorial station

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Extended Abstract

One important parameter used in all topside functions for the approximation of the ionospheric topside profile is the scale height, which can be estimated from ionogram. The scale height is an important topside profile parameter which determine the shape of the topside density profiles and has been reported by Luan et al., (2006) to have an intrinsic connection to the ionospheric dynamics, plasma temperature and compositions. For the extrapolation of topside profile, the α-Chapman function uses a constant scale height (known as α-Chapman scale height (Hm)) that was derived from the ground based ionosonde measurement (Reinisch and Huang, 2004).

Investigations of the variation of H_m at different region have been conducted using measurements from different types of instruments (e.g. Liu et al. 2006; 2007). Consequently, this paper investigates the diurnal and seasonal variation of Hm. Although, Nambala et al. (2008) has investigated the variation of Hm over a middle latitude station in the African region, this work is the first attempt to investigate the variation of Hm over the African equatorial location. Also, the relationship of Hm with other ionospheric parameters such as the total electron content (TEC), the peak F2 peak height (hmF2), the critical frequency (foF2) and the bottomside thickness parameter (B0)).

The dataset used consists of the Digisonde derived parameters (i.e. hmF2, foF2 and Hm) and Global Positioning System (GPS) derived TEC (GPS-TEC). The Digisonde and the GPS receiver where the TEC measurement is obtained are both collocated at Ilorin (Geog. Lat. 8.50^{o}N; Long. 4.50^{o}E, dip: –7.9^o), an African equatorial station.

The result obtained indicates that the diurnal variation shows an early morning increase with maximum around the noon period, followed by a decrease till nighttime. The variation however shows significant seasonal trend. A notable finding is the highest value observed in December solstice and the lowest in June solstice over the station. This may be due to the influence of the ion-neutral drag and the topside thermal structure on the shape of the topside ionosphere. Hm also has a good correlation with the F2 layer bottomside thickness parameter (B0) and the total electron content (TEC); and moderate correlation with F2-layer critical frequency (foF2) and peak height (hmF2). The correlation coefficient obtained however do not show significant seasonal difference. The study also demonstrates that the good correlation between H_m and B0 could provide an excellent opportunity to determine H_m from the already established B0 model (if well modeled at the station) for possible application in topside profilers.

References

Liu, L., Wan, W., Ning, B., (2006). A study of the ionogram derived effective scale height around the ionospheric *hm*F2, Ann. Geophys., 24, 851–860.

Liu, L., Wan, W., Zhang, M.-L., Ning, B., Zhang, S.-R., Holt, J. M., (2007b). Variations of topside ionospheric scale heights over Millstone Hill during the 30-day incoherent scatter radar experiment. Ann. Geophys., 25, 2019–2027.

Luan, X., Liu, L., Wan, W., Lei, J., Zhang, S.-R., Holt, J. M., Sulzer, M. P., (2006). A study of the shape of the topside electron density profile derived from incoherent scatter radar measurements over Arecibo and Millstone Hill, Radio Sci., 41, RS4006, doi:10.1029/2005RS003367.

Nambala, F.-J., McKinnell, L.-A., Oyeyemi, E., (2008). Variations in the ionospheric scale height parameter at the F2 peak over Grahamstown, South Africa. Advances in Space Research 42 707–711

Reinisch, B. W., X. Huang, A. Belehaki, Ilma, R., (2004). Using scale heights derived from bottomside ionograms for modeling the IRI topside profile, Adv. Radio Sci., 2, 293–297.

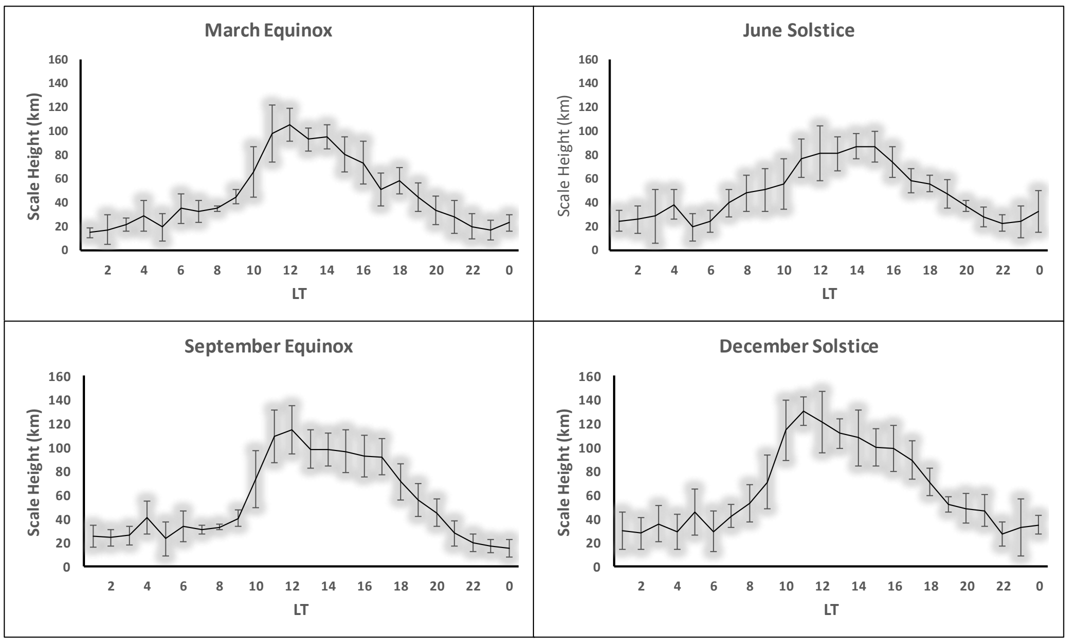

Fig 1: Diurnal variation of Chapman's scale height for the months of (a) April (b) June (c) September and (d) December in 2010 representing the different seasons of the year. The vertical bar shows the hourly standard deviation.

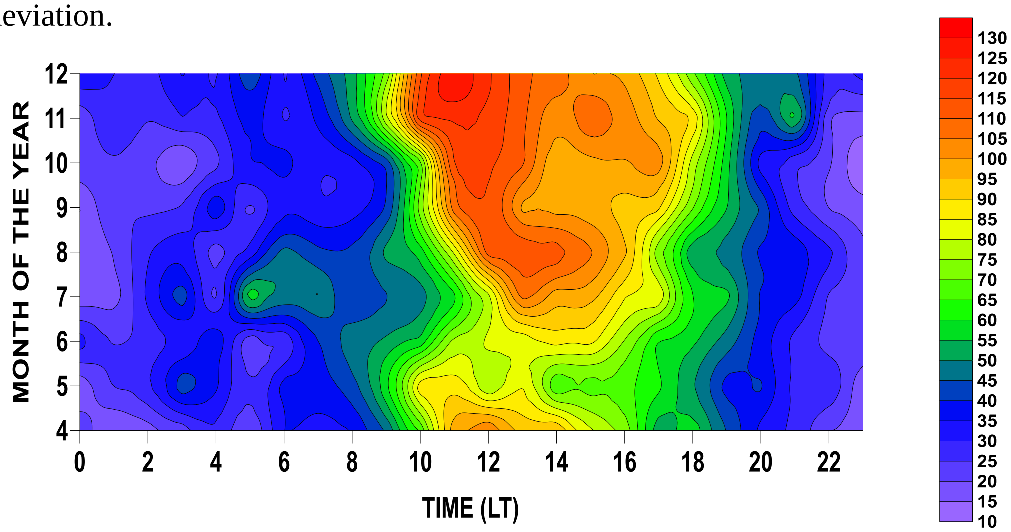

Fig 2: The contour plot showing the month-to-month variation of H_m for the months of April to December 2010.