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THE ABSENCE OF EQUATORIAL SCINTILLATION ACTIVITY PRIOR TO A LARGE GEOMAGNETIC STORM AND A NON-STORM EVENT

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Abstract.

1 INTRODUCTION

In a recent study, we have investigated the relationship between the observed hf values at 19:30 LT from the Jicamarca digital sounder and the Total Hourly Mean S_4 (THMS4) values obtained from the SCINDA UHF Ancn, Peru S_4 observations. The nightly THMS4 parameter is a derived quantity ranging from 0 to 5. It specifies both the intensity and duration of scintillation activity as measured from a ground station where a value of 1 indicates moderate activity and a value of 3-5 is an indication of more intense scintillation. While it has been shown that there exists a threshold in post-sunset ExB drift velocities that determine whether or not scintillation activity will occur, the important parameter is

the height of the F layer since this has been shown by Sultan[1] and others to critically affect the Rayleigh-Taylor (R-T) growth rate values. This study investigated the relationship between the observed hf values at 19:30 LT from the Jicamarca digital sounder and the subsequent THMS4 values obtained from the SCINDA UHF Ancn observations. The advantage of using readily available hf values at 19:30 LT lies in the fact that the height of the F layer is the more critical parameter to associate with R-T growth rates.
Figure 1 compares the THMS4 values obtained from Ancn UHF observations with the hf values at 19:30 LT from the Jicamarca sounder for several pairs of months in 2002, 2003, and 2004. We have qualitatively determined the threshold values of hf values ($h'f_{thr}$) which seem to act as demarcation markers for nightly THMS4 values significantly less than 1, indicative of low scintillation activity, and those significantly greater than 1, indicative of stronger scintillation levels. The hF threshold values for 2002, 2003 and 2004 are, respectively, 400, 340 and 310 km.

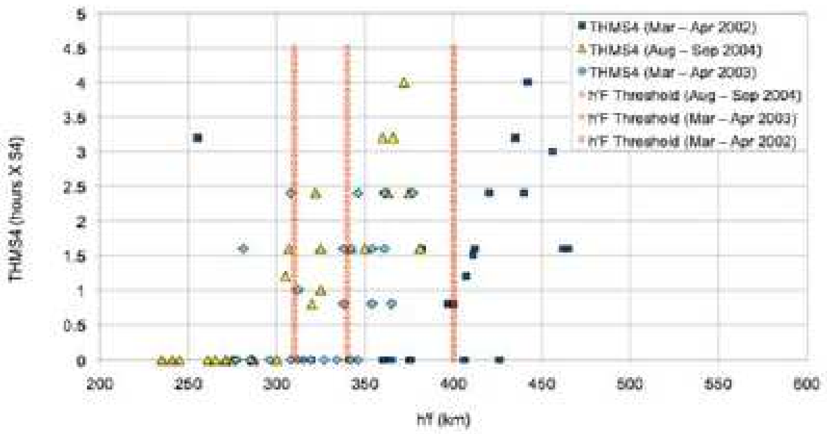

Figure 1: Estimated threshold hF values for 2002, 2003 and 2004.

The average F10.7 cm flux for each of the pairs of months has been determined and Figure 2 displays the linear relationship that exists between the threshold hf altitudes and the month-pair averaged F10.7 cm flux from 2002 to 2008.

2 RESULTS

2.1 Results prior to and after the Halloween, 2003 geomagnetic storm event

We have incorporated the relationship between $h'f_{thr}$ and the F10.7 cm flux shown in Figure 2 to calculate the $h'f_{thr}$ values for each day prior to and after the Oct., 2003 Halloween storm (Oct. 5 to Nov. 6). In Figure 3, we compare the $h'f_{thr}$ values with the h'f (1930 LT) values and the THMS4 values for each of the days. The top portion of Figure 3 displays the daily F10.7 cm flux values (green triangles), the calculated $h'f_{thr}$ values (blue diamonds) and the observed h'f (1930 LT) values for each day (red squares). Note that the period before Day 290, when F10.7 is relatively constant at 100, the h'f (1930 LT) values are mostly higher than the $h'f_{thr}$ value of ~ 310. This implies that scintillation activity is more likely to occur. After Day 290, the F10.7 cm flux begins to increase dramatically and as a consequence, $h'f_{thr}$ increases dramatically, $\sim 500Km$ on Day 302. On the other hand, the daily h'f (1930 LT) values, after Day 290, actually decrease initially, increase for 5 days, decrease for 4 days and then increase for 5 days. In fact, for the entire period between Day 290 and Day 310, hf (1930 LT) values lie below the $h'f_{thr}$ values implying that scintillation activity is less likely to occur. The bottom portion of Figure 3 which plots the daily THMS4 values between Days 279 and 310 bear this out. Before Day 290, the average THMS4 value is 1.65 and for the period between day 290 and 310, the average THMS4 value has dropped to 0.59.

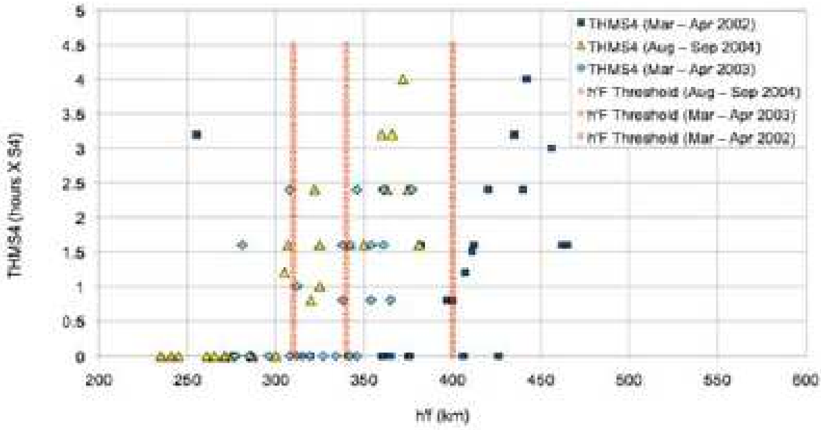

Figure 2: Threshold h'F values vs. F10.7 cm flux values for [1] 2008 (Aug, Sep), [2] 2005 (Aug, Sep), [3] 2004 (Aug, Sep), [4] 2003 (Mar, Apr) and [5] 2002 (Mar, Apr).

2.2 Results during a non-storm event

As described in section 2.1, We have incorporated the relationship between h'f thr and the F10.7 cm flux shown in Figure 2 to calculate the $h'f_{thr}$ values for each day during a non-storm event (March 22 to April 13, 2003). In Figure 4, we compare the $h'f_{thr}$ values with the h'f (1930 LT) values and the THMS4 values for each of the days. As in Figure 3, The top portion of Figure 4 displays the daily F10.7 cm flux values (green triangles), the calculated $h'f_{thr}$ values (blue diamonds) and the observed h'f (1930 LT) values for each day (red squares). For this non-storm event, the F10.7 cm flux is relatively steady at ~ 80 units before Day 85, increases to ~ 150 between Days 85 and 95, and then decreases back to ~ 100 after Day 95. The calculated $h'f_{thr}$ values range from 300 km up to 375 km and back to ~ 300 km. Between Days 79 and 85, the h'f(1930 LT) altitudes lie above the threshold altitudes, but as $h'f_{thr}$ increases, h'f (1930 LT) values now lie below the threshold altitude between Days 85 and 95.After Day 95, when $h'f_{thr}$ has dropped back to 300 km, the h'f (1930 LT) once again lie above $h'f_{thr}$.

The occurrence or non-occurrence of scintillation activity as measured by THMS4 and displayed in the bottom portion of Figure 4, for each of the 3 time periods can be explained

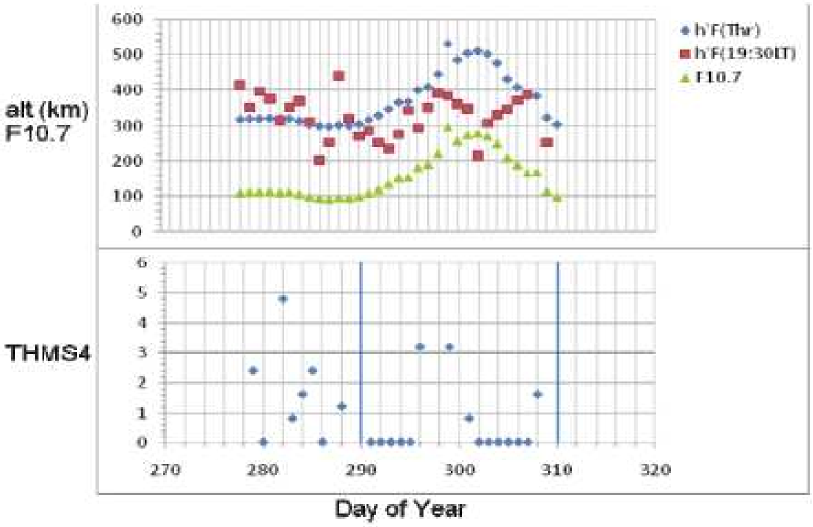

Figure 3: F10.7, $h'f_{thr}$, h'f (1930 LT), and THMS4 values vs Day of the Year, 2003.

by the relative altitudes between h'f (1930 LT) and $h'f_{thr}$ even for this non-storm event. The average THMS4 value before Day 85 is 0.86, between Days 85 and 95 it is 0.40 and after Day 95 the average value is 0.82. The intriguing question to ask is why, as F10.7 cm flux increases, there is not a corresponding increase is the PRE ExB drift after sunset that would be reflected in an increase in h'f (1930 LT) values.

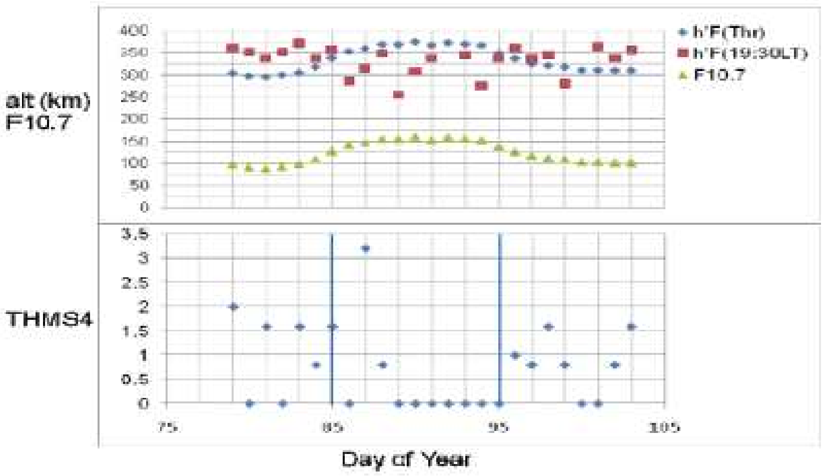

Figure 4: F10.7, $h'f_{thr}$, h'f (1930 LT) and THMS4 values vs Say of the Year, 2003.

REFERENCES

[1] P. J. Sultan, Linear theory and modeling of the Rayleigh-Taylor instability leading to the occurrence of equatorial spread F, J. of Geophys. Res, 101(A12), 26875-26891, (1996).