STUDIES OF NIGHTTIME PLASMA DRIFTS AT A LOW LATITUDE STATION OVER A SOLAR CYCLE

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ABSTRACT

The ionospheric plasma drift is one of the most important parameter for understanding the dynamics of ionospheric F- region. Using incoherent scatter measurements at Arecibo, we have derived the vertical velocity (Vz) from the components of field parallel (Vpar) and field perpendicular north (Vper) for a full solar cycle. The local time variation of Vpar and Vper show strong anticorrelation without any time lag for most of the night. The height of F-region peak density (hmF2) sometimes correlates with one component of the velocity, while at other times it correlates with other velocity component.

INTRODUCTION

The incoherent scatter (I.S.) radar has made it possible to measure the drift velocity of ionospheric plasma in the E and F regions. The I.S. radar at Arecibo (18.4 N, 66.7 W, 30 N mag. lat.) operating at a frequency of 430 MHz with a peak transmitter power of 2.5 MW has an outstanding capability of measuring the line of sight (LOS) velocity in a continuously scanning mode with a steerable beam swung clockwise and counterclockwise over 360^0 azimuth at a fixed elevation angle of 75^0. A set of LOS velocity measured at various directions are combined into drift velocity vectors by assuming that ion velocities are uniform throughout the entire region of ionosphere over a horizontal distances of about 200 km. These ion velocities are converted into geomagnetic coordinate as components of field parallel (Vpar) and field perpendicular (Vper), positive northward in magnetic meridian plane and zonal drift ($V_{\perp E}$), positive eastward in the horizontal plane. In this paper we present the results of analysis of I.S. measurements of nighttime plasma drifts measured at Arecibo for the period from 1986 to 1994 to look for correlation between the plasma drifts over a solar cycle 22. We have also derived vertical velocity (V_z) to look for any link between plasma drift, vertical velocity and height of F-layer peak (hmF2).

DATA BASE

The Vpar and Vper are not directly observed but are derived from combination of 12 LOS velocity measurements in each 360^0 azimuth scan with a cycle period of about 16 minutes. These drift velocities are available from NCAR, Boulder, Colorado, USA in the height range between 144 and 664 km with interval of 37 km with a time resolution of about 20 minutes. As plasma drift don't show significant variation with altitude, we have averaged these velocities between 300 and 500 km.

RESULTS AND ANALYSIS

Fig. 1 shows the comparison of Vpar and Vper during three seasons of solar cycle 22. The close inspection of local time variations of average plasma drift seen together reveals that strong motion upwards in Vpar is accompanied by downward motion in Vper and vice versa. This anti-correlation is very often quite instantaneous without any time lag leading to horizontal motion of F-region, as the vertical projection of the parallel and perpendicular drift components almost cancel each other. This strong anti-correlation of plasma drift are always well developed for most of the night.

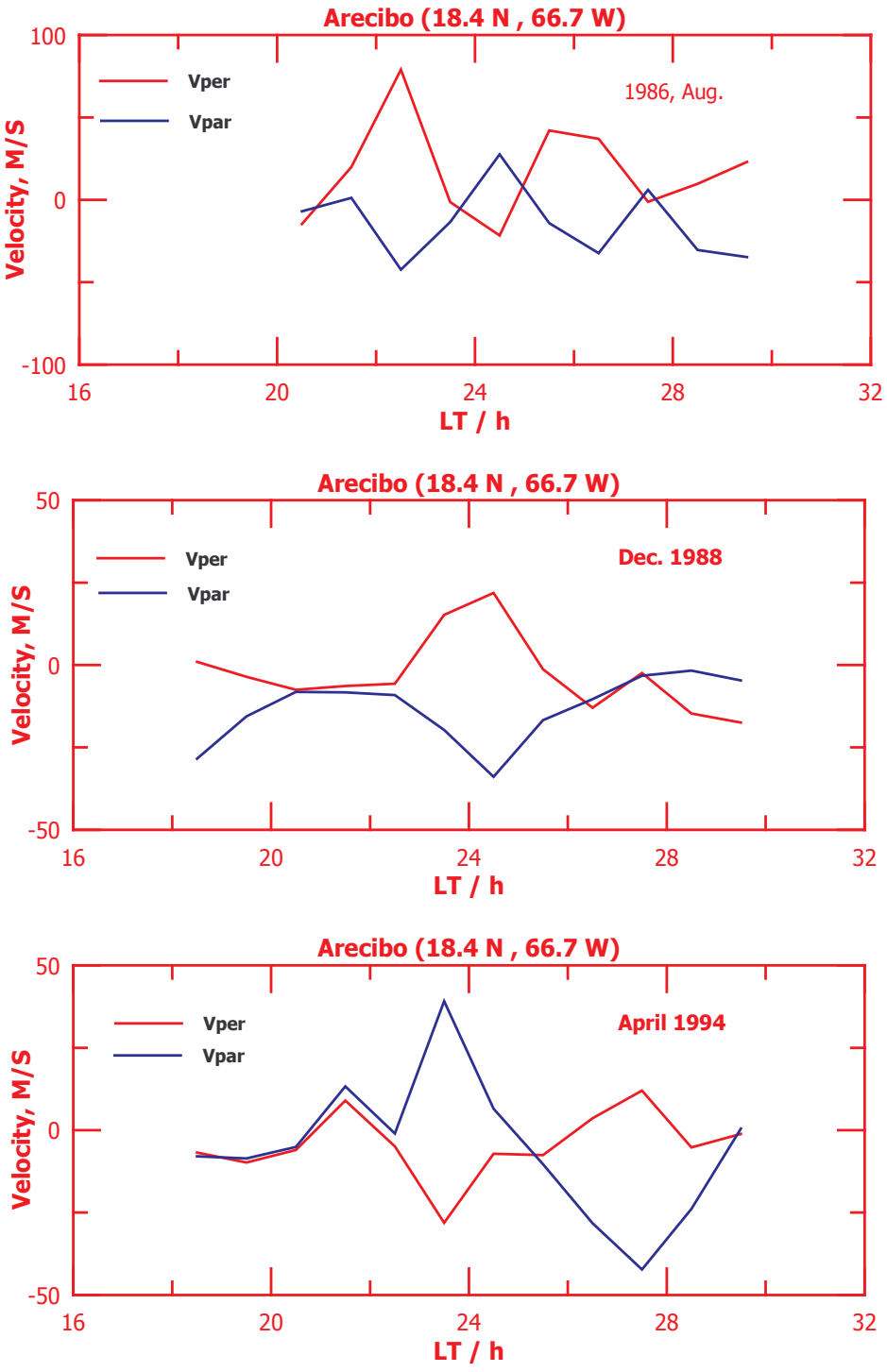

Fig. 1 Ion drift velocities in the nocturnal ionosphere during different seasons of solar cycle 22 revealing good anti-correlation between Vper and Vpar components.

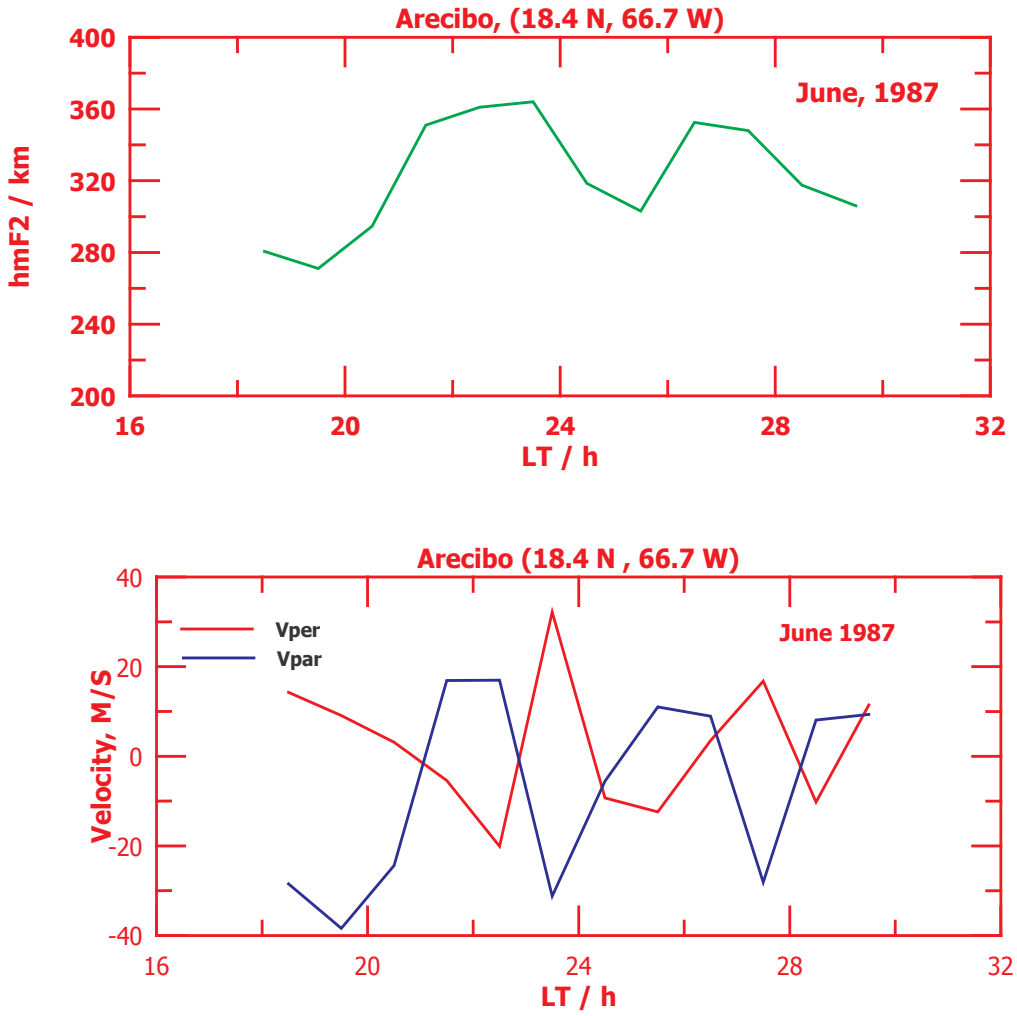

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Fig. 2 The comparison of velocity components with peak height of F-layer showing positive correlation with Vpar before 2300 hrs and with Vper after midnight.

The fluctuations in ion drift velocity are also correlated with changes in diffusion velocity resulting from changes in peak height of F-layer. Fig. 2 shows one such comparison where there is a positive correlation between Vpar and hmF2 in pre-midnight hours whereas in post-midnight hours Vper is seen to be positively correlated with hmF2.

In Fig. 3 it is shown how hmF2 responds to variation in vertical drift velocity. It is clear from the figure that strong upward vertical drift results in rise of the F-layer and vice versa.

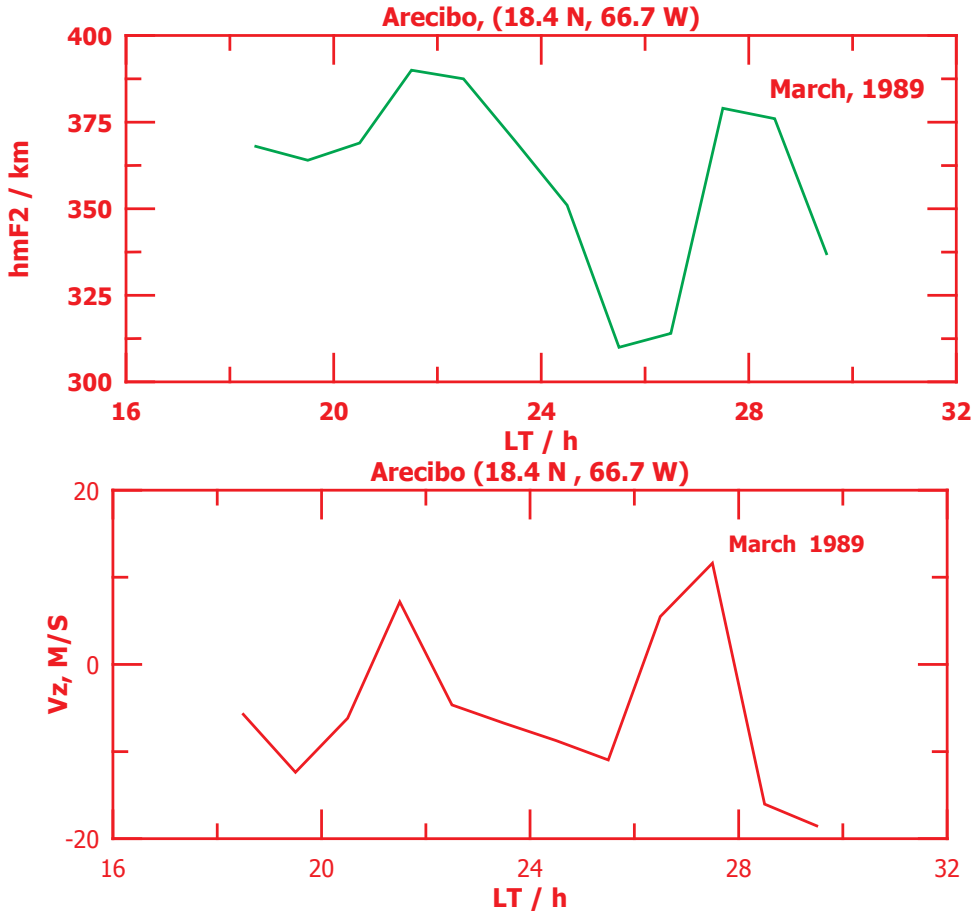

Fig. 3 The vertical velocity Vz compared with F-layer peak height exhibiting positive correlation.

CONCLUSION

These results are consistent with earlier observations of various workers using I.S. measurements at Arecibo as well as at other stations [1-3].

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