A PRELIMINARY STUDY ON THE IMPACT OF POST SUNSET E REGION CHARACTERISTICS ON THE DEVELOPMENT OF ESF OVER A LOW LATITUDE STATION VISAKHAPATNAM

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Abstract - Analysis of ionogram data from a low latitude Indian station Visakhapatnam (17.7° N , 83.3° E), India for the period 2001 and 2006 representing typical high and low solar activity periods indicates the role played by E-region ionization on the development of equatorial Spread – F. Presence of strong E-region during post sunset hours seems to inhibit the growth of Spread – F. Since an enhanced E-region reduces the F-region conductivity and thereby the post sunset upward drifts, it may lead to the suppression of Spread – F. Further, since the Sporadic E can change the Pedersen conductivity and hence the polarization fields that are mapped into the F-region, it is felt that the growth rate of ESF could change as much as by an order of magnitude affecting the incidence of Spread F. The temporal variability of the Sporadic E versus Spread F as function of season and solar activity are investigated and the results are being reported.

Key words : **sporadic E, spread F ,ionosphere, Pederson,postsunset.**

1.Introduction

In a series of research works in the recent years a link between the spread-Es phenomenon and sporadic –E has been given preference. One of the turbulent phenomena in the E-region is spread-Es, which have been scientifically investigated by several researchers, (Bowman, 1985; Whitehead, 1989; Barnes, 1992; Mathews, 1998). Spread-Es is observed as diffusivity of the traces of sporadic E-layers on ionograms of vertical sounding stations. It is supposed that spread-Es is a consequence of ionospheric

Processes in sporadic E-layers at altitudes of 100 km. According to a wealth of observations, the diffusivity takes place during less than 10% of the night, and it is

found to less than 3% at day time. Spread-Es generally occurs more often during the 11 years solar cycle minimum and depends strongly on the season. Spread-Es is mainly found in the frequency range of fbEs<2.5 MHz. The assumption exists that the spread effect is caused by acoustic pulses propagating in the atmosphere (Bowman, 1985; Whitehead 1989).

The phenomenon of equatorial spread-F on ionograms was found as diffuse traces by Booker and Wells. Krishna murthy found that the occurrence of ESF over topside is followed by the ESF bottom side with about two hours time delay, in addition to that different aspects of occurrence range and frequency spread-F were observed on ionograms. Perkins (1973) introduced the concept of bottom side F-region instabilities presumed to lead to mid-latitude spread-F. Spread-F was originally defined in terms of multiple highly disturbed F-region traces on ionograms. Woodman and LaHoz [1976] observed these F region irregularities associated with the range spread in reflected frequencies seen in radar data. Since then, the term equatorial spread F (ESF) has ballooned to encompass instabilities ranging 7 orders of magnitude in size, from centimeters to hundreds of kilometers.

The search for links between F-region phenomena and the E-region has a long analysis in both experimental and theoretical research. Es layers, with blanketing frequencies exceeding 4 MHz (~2 * $10^5 cm^{-3}$), have been seen at night in conjunction with a sodium layer created by meteor ablation [Batista et al., 1989].

Andrew W.stephen et.al in his investigation on Suppression of Equatorial Spread-F by Sporadic E quantitatively found the influence of a low-latitude, premidnight sporadic E layer might have on the daily and hourly development of equatorial spread F (ESF).

Sporadic E layers observed after dusk do not regularly reach these values, they are

not a likely source of the daily variability in ESF. However, they pointed out that even a mild enhancement in the post sunset E region could lead to a significant suppression of ESF if it also inhibits the upward plasma drift of the prereversal enhancement, a key variable in the growth rate of the equatorial spread F instability .To give support they also have made a model calculation of Pederson conductivity and concluded that Es layer can change the Pederson conductivity ratio and thus the growth rate of ESF since the flux tube–integrated Pedersen conductivity as it affects the growth rate of the Rayleigh-Taylor instability, which governs the initial development of ESF. They sourced out that the

growth rate is lowered by an order of magnitude with a density of $1*10^6$ cm^{-3} in a slab from 115 to 120 km. As a result of there discussions they have pointed out that there are three parameters which must be optimized to obtain the maximum effect First, the magnitude of the change is dependent on the plasma densities in the Es layer.

Second, layers at higher altitudes can take advantage of smaller ion-neutral collision frequencies, leading to a greater reduction in the conductivity ratio. Finally, the effect is larger at later times, when an identical Es layer will be more influential in the Pedersen

Conductivity ratio. Stephan et.al have compared data from March 4 and March 26, 1998,

taken by a Digisonde [Reinisch, 1996] at the Jicamarca Radio Observatory (12^0S, 77^0 W; 2^0 N magnetic latitude), they observed that these two days differ from each other ,March 4 did not exhibit any strong ESF, while March 26 demonstrated the signatures

associated with the presence of these instabilities. In particular, the sudden uplift in h'F followed by the gap in observable foF2 and h'F values is characteristic of ESF. In addition, they also considered for comparison the GPS station in Arequipa, Peru (16_S, 71_W; magnetic dip 3.5_S), and found that they recorded strong ESF signatures on March 26 but not on March 4. As described by Mendillo et al. [2000] Mendillo et al. [2001], the GPS face fluctuation index, if Fp values is below 50 units it signifies the absence of ESF, while if the values are 200 and above it results from a strong ESF event. Thus by direct measure of ESF on the ionosonde at Jicamarca and by its GPS signatures at Arequipa, they concluded that a classic case of day-to-day variability of post sunset ESF during a month of high occurrence rates.

1.1 Data Base

The ionospheric parameters foEs (critical frequency of the E-region), fbEs (blanketing frequency of the sporadic E), h'F (F region minimum virtual height) and foF2 (critical frequency of the F-layer) were taken from ionograms registered at Visakhapatnam, (17.7° N, 83.3° S) at 15 min intervals. The ionograms were carefully checked and those showing the presence of a sporadic E layer and spread F and at times proceeding the sunsets were chosen for the present study.

1.2 Results and Discussion

The data for the period 2001 and 2006 representing typical high and low solar activity periods have been sorted out as two the plots have been plotted based on the ionogram data recorded in the low latitude station Visakhapatnam. On X-axis the time in hours is plotted and height and frequency on Y-axis respectively, the star symbol indicates the blanketing and triangle indicates h'Es, and squares with blue foF2, and squares with black h'F2, the spread-F duration have been showed by arrows (the onset and ending).

The present work continues the search for the suppression of spread-F by Sporadic E with the Visakhapatnam data available for the years 2001 and 2006. A few plots are considered which compares with the earlier investigations and sustain few results equal to them. Though several days have been found for the observation only selected dates have been presented in the present discussion.

The plots of March 7th ,September 28th ,October 5th of 2001 and March 12th of 2006 showed only the signatures of ESF,the duration of Spread F was observed around about 2 to 4 hrs. On March 7th 2001 and March 12th 2006 the cases examined found the sporadic-E (here we refer the presence of h'Es and fbEs and foEs) during the whole day uptill around 1800hrs LT and after hours we found the signatures of ESF which was about 2hrs and the sporadic layer completely disappeared at this time.

On observed days in the year 2001 29th May, 6th June, 5th July, 2nd Aug and in 2006 Feb 2nd, Feb 3rd 2006 Sporadic E was observed from around 1600hrs to 2400hrs,anyhow we have restricted our study to post sunset hours we found in all the cases spread-F was not present . The reason behind choosing of high solar activity year is just the spread f events will be more after sunset. The concentration is on the events when the spread f is present or not with simultaneous occurrence of E_s.

Table 1. Statistical data of Occurrence of the events

Season	**No. of days under study**	**No E_S but Spread F is present**	**ES present but no spread F**	**Both ES and spread F are present**
Winter	20	06	02	12
Summer	20	01	15	04
Equinox	26	22	00	04

The above table shows the statistical study of occasions occurring each showing in a high solar active period 2001. In this work we find most of the cases of coupling mostly in winter and of same number in summer and equinox. The occurrence of spread –F alone is found more in equinox and the presence of sporadic E of about 15 occasions is found in summer.

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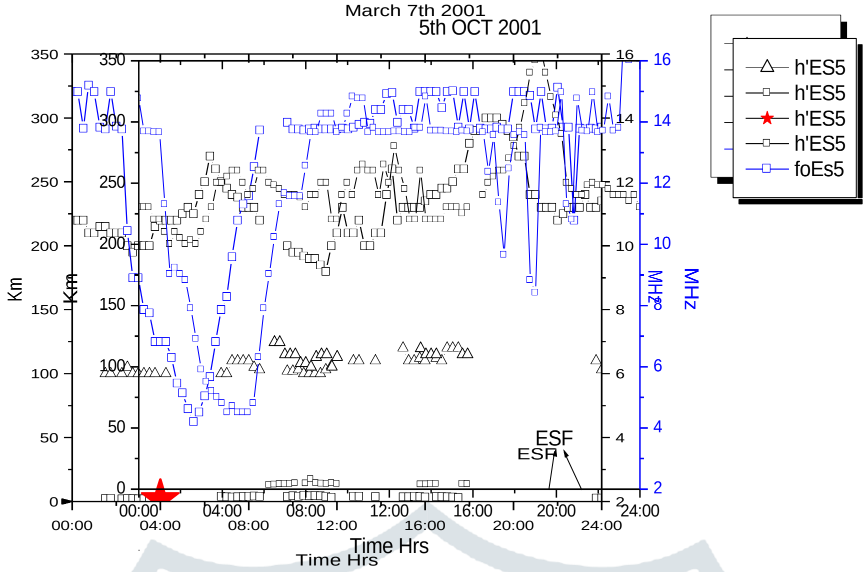
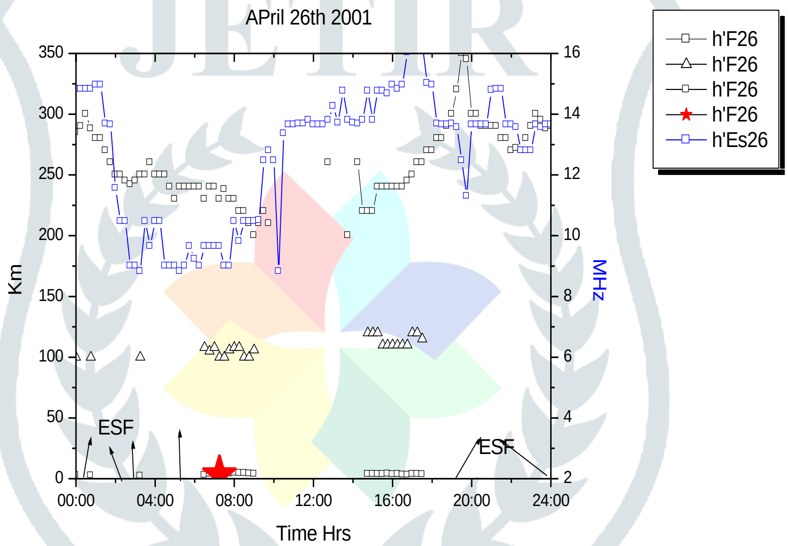
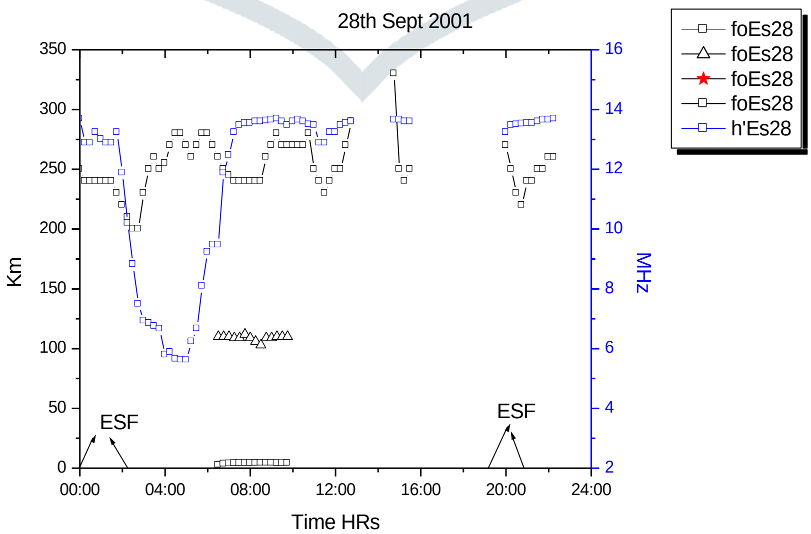
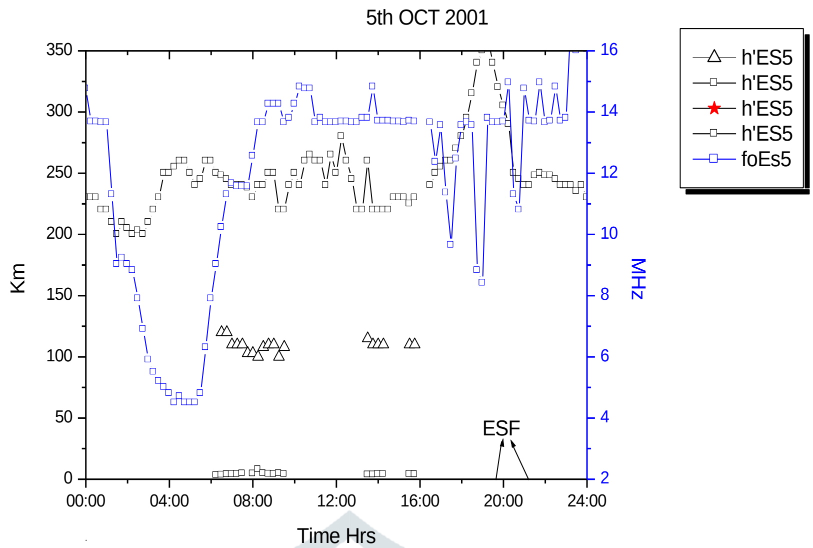
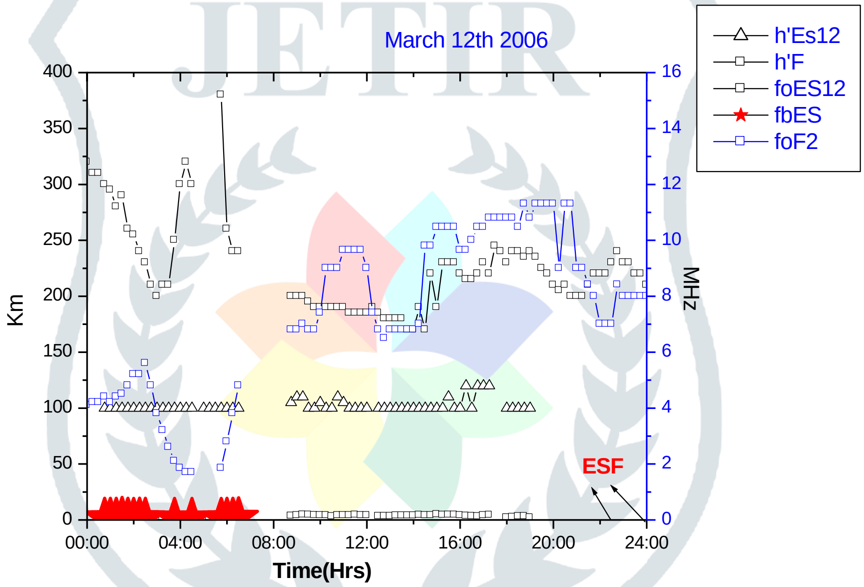
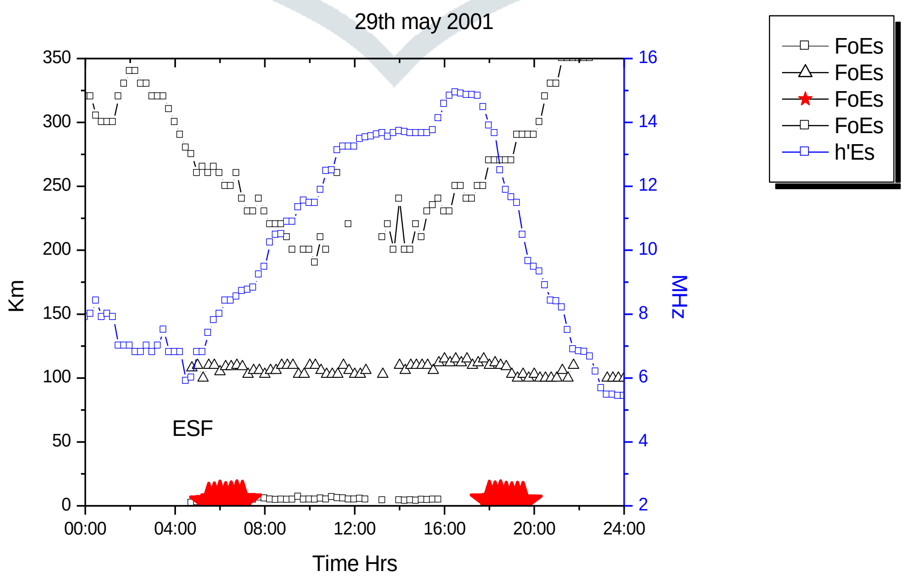

March 7th 2001
5th OCT 2001
h'ES5
h'ES5
h'ES5
h'ES5
foEs5
Km
MHz
ESF
Time Hrs

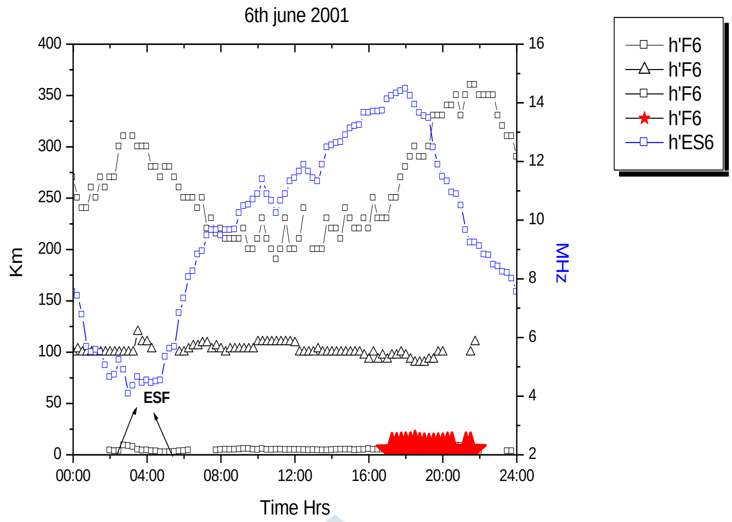

APril 26th 2001
h'F26
h'F26
h'F26
h'F26
h'Es26
Km
MHz
ESF
ESF
Time Hrs

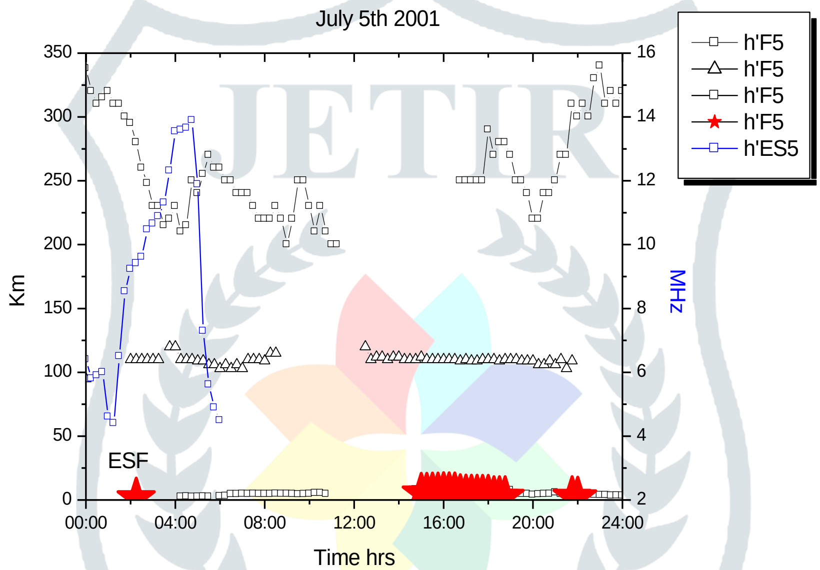

28th Sept 2001
foEs28
foEs28
foEs28
foEs28
h'Es28
Km
MHz
ESF
ESF
Time HRs

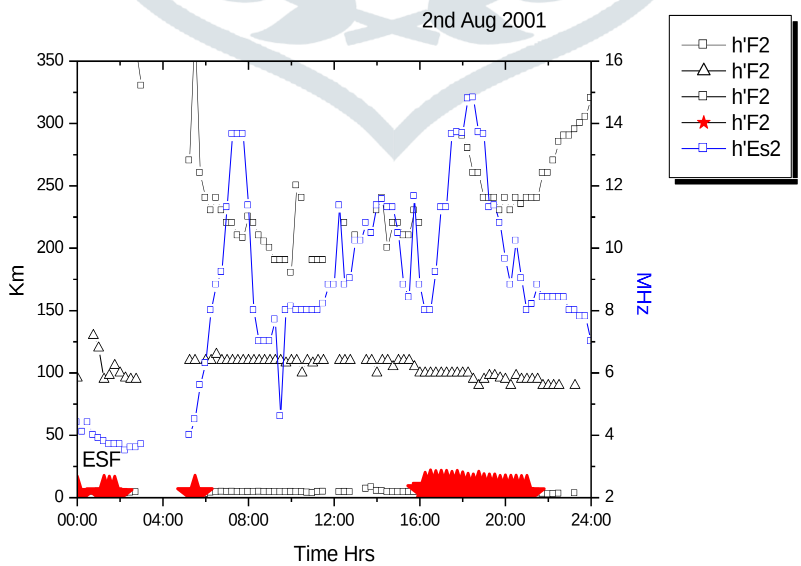

5th OCT 2001
h'ES5
h'ES5
h'ES5
h'ES5
foEs5
Km
MHz
ESF
Time Hrs

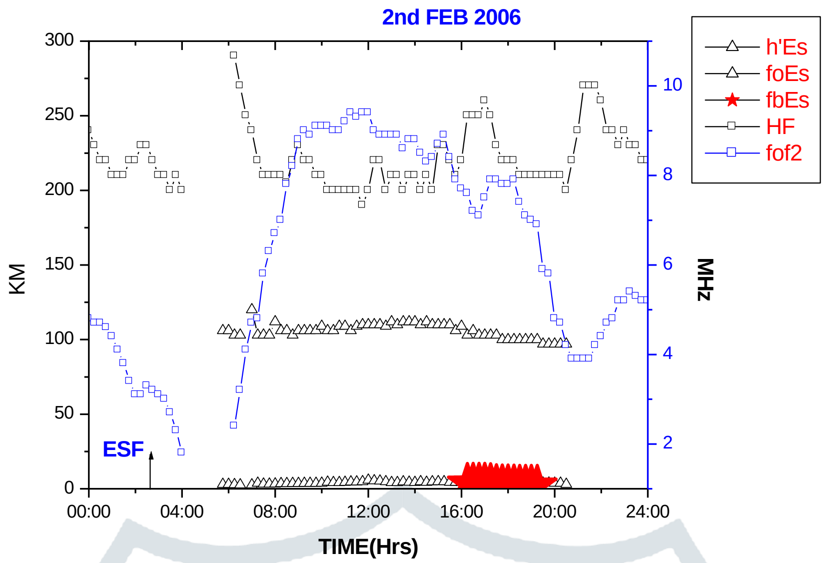

March 12th 2006
h'Es12
h'F
foES12
fbES
foF2
Km
MHz
ESF
Time(Hrs)

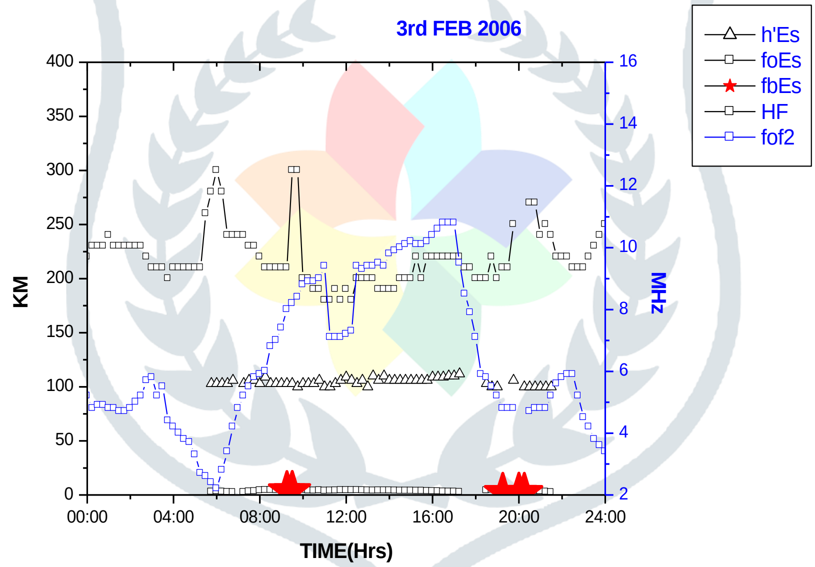

29th may 2001
FoEs
FoEs
FoEs
FoEs
h'Es
Km
MHz
ESF
Time Hrs


6th june 2001
Km
MHz
Time Hrs
ESF
h'F6
h'F6
h'F6
h'F6
h'ES6


July 5th 2001
Km
MHz
Time hrs
ESF
h'F5
h'F5
h'F5
h'F5
h'ES5


2nd Aug 2001
Km
MHz
Time Hrs
ESF
h'F2
h'F2
h'F2
h'F2
h'Es2





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