Transient echo Experiments observed using Indian MST radar

Associates

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3 Jicamarca radar Peru

Our objectives are

- Response of E-region FAI to the meteor shower
- The behavior of meteor trail
- Characteristics of Lightning echoes during active weather over Gadanki

Observation on E-region Field Aligned Irregularities in Association With Meteor Shower Over Gadanki (13.5° N, 79.2° E)

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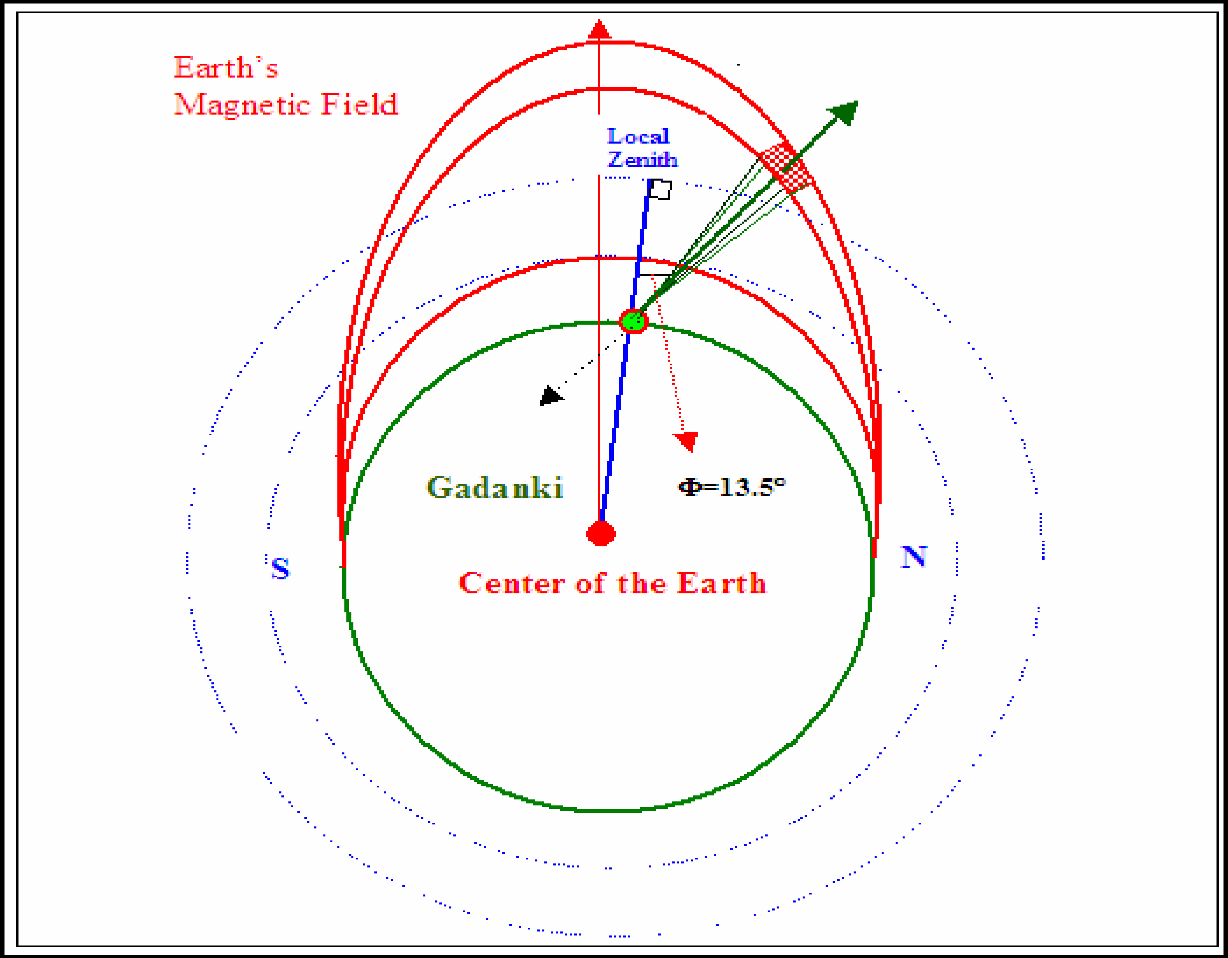
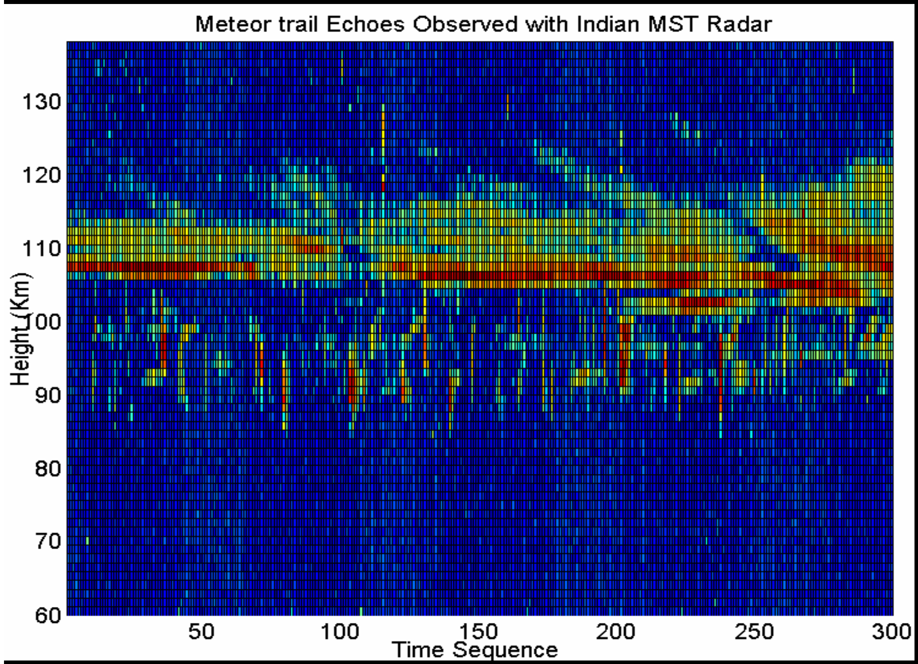
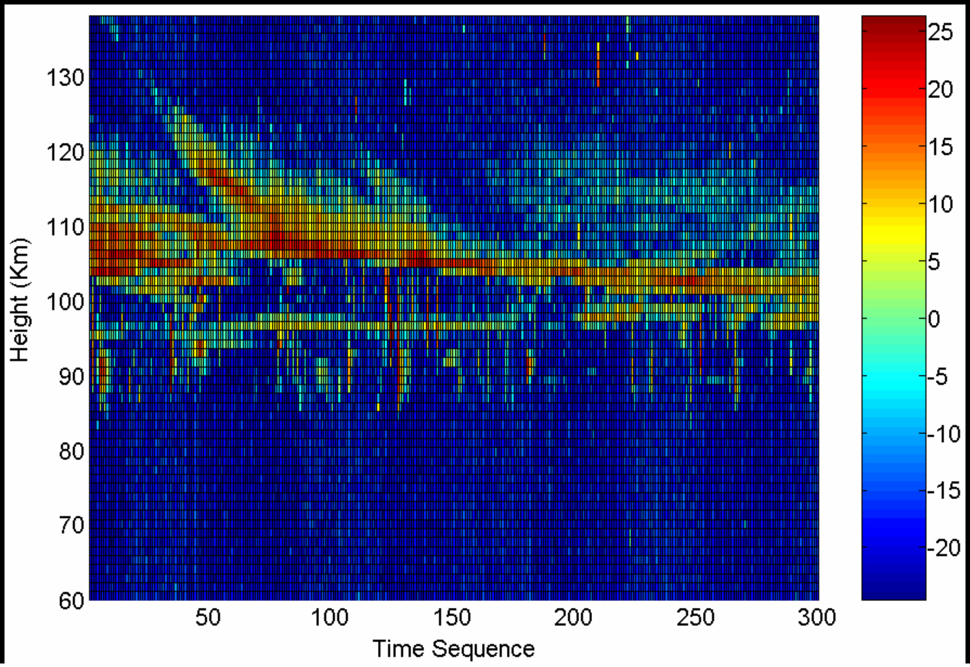
3 Jicamarca radar, Peru

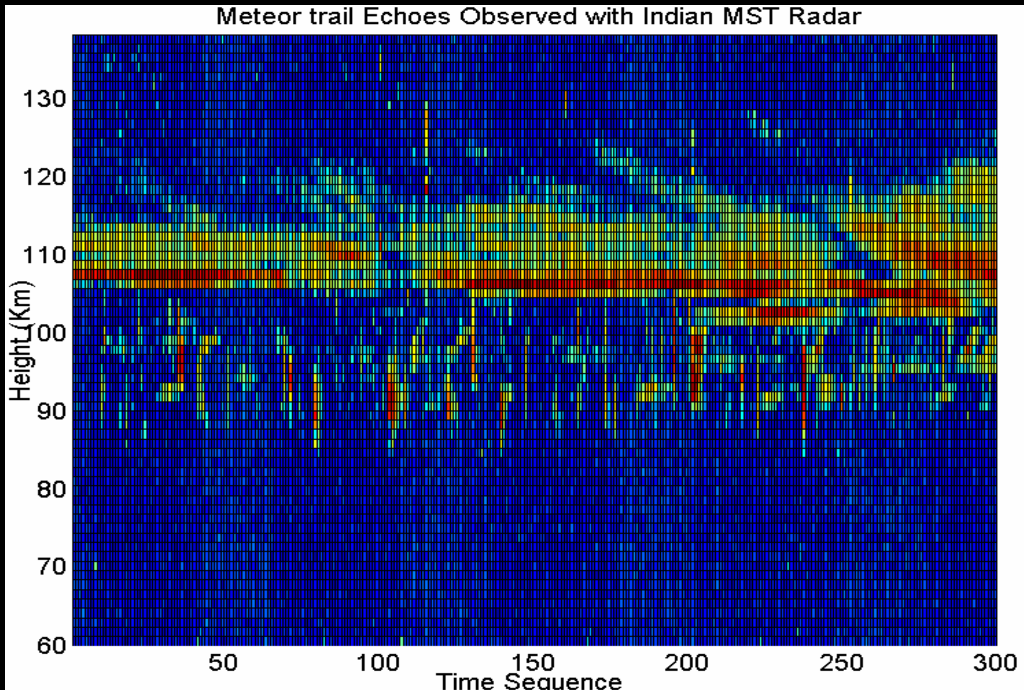
Beam Pointing direction for obtaining FAI echoes





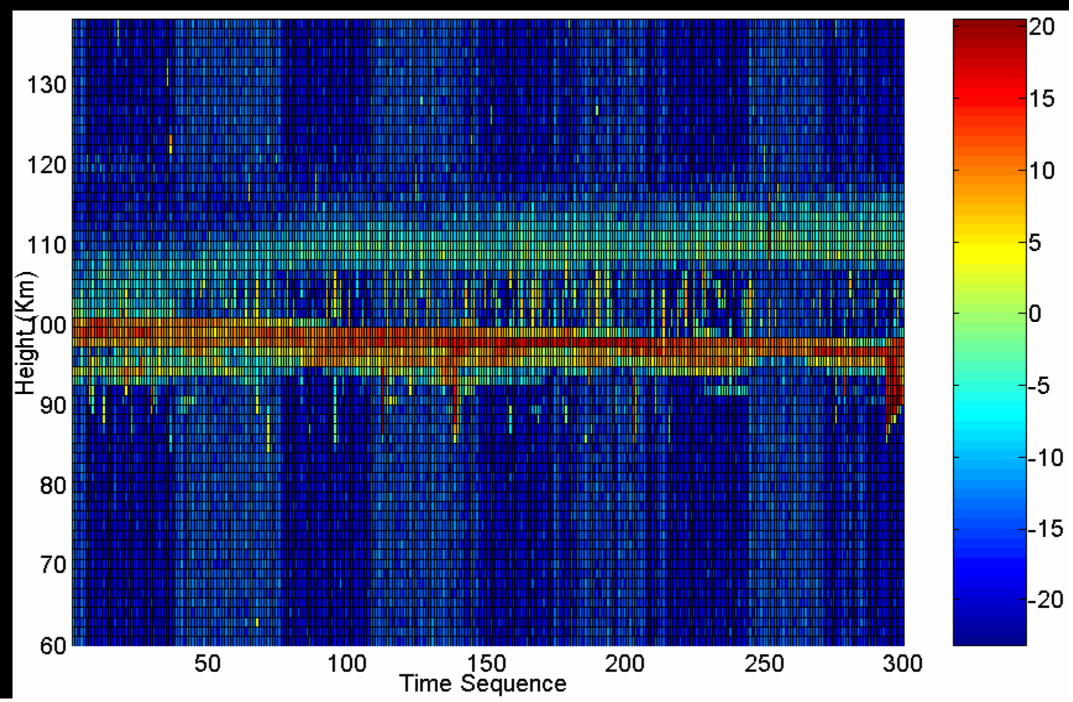
Co-existence of Field Aligned Irregularities With Meteor Trail Penetration



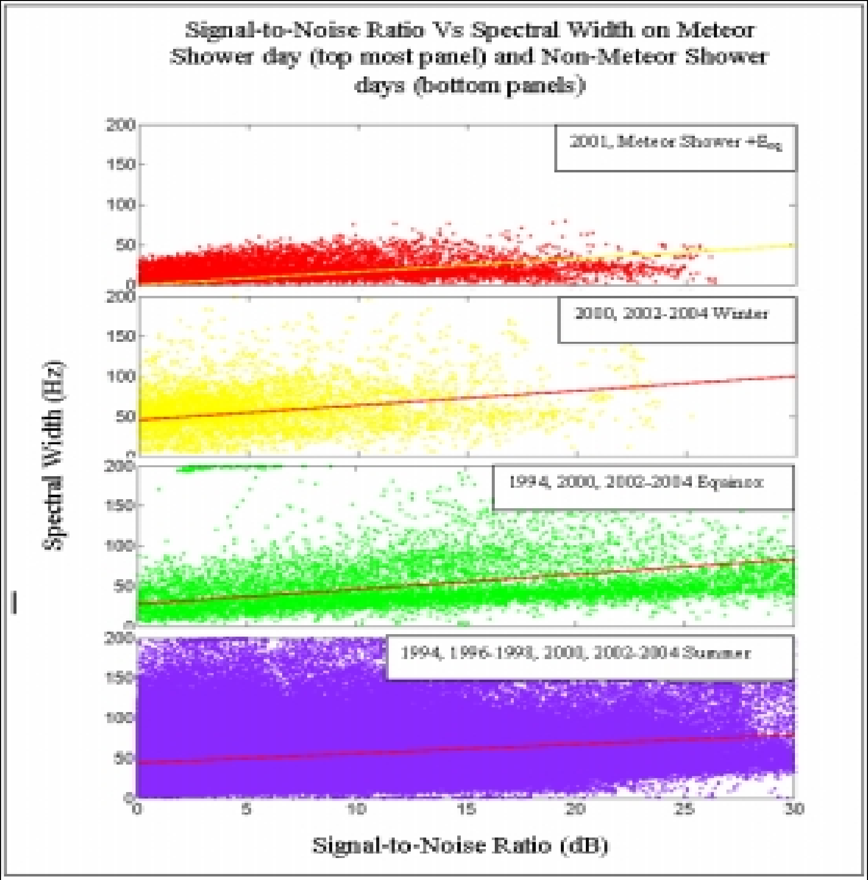


Meteor Trails
Below the FAI
Layer

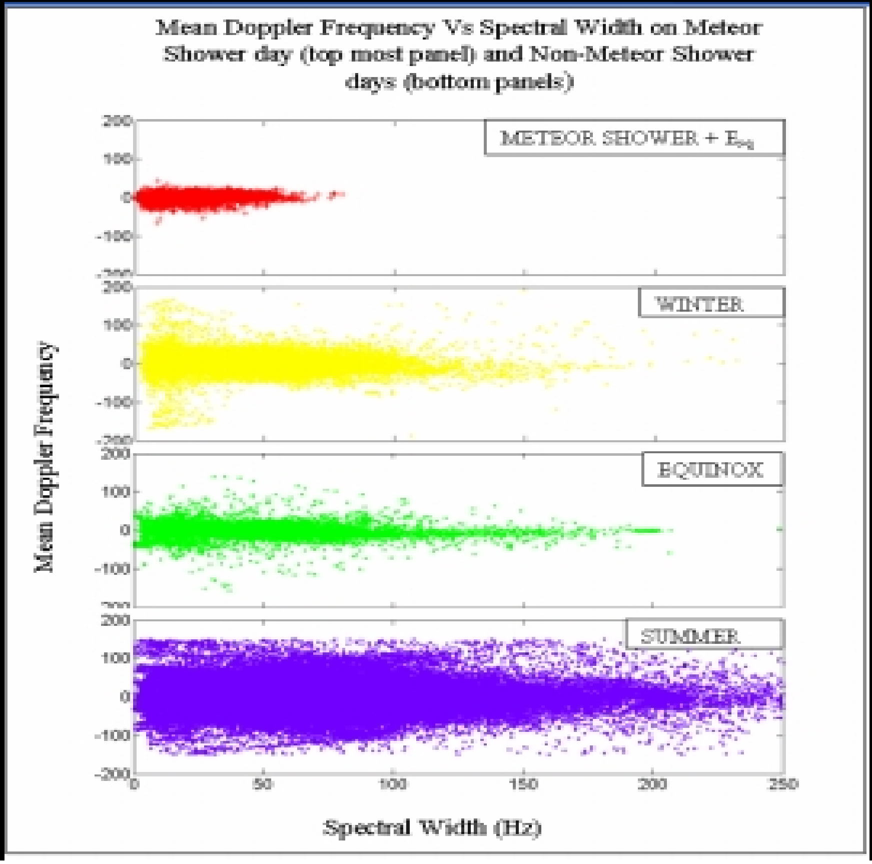
Meteor Trails
Over the FAI
Layer



Spectral Width Vs Signal-to-Noise Ratio Characteristics Corresponding to the Event



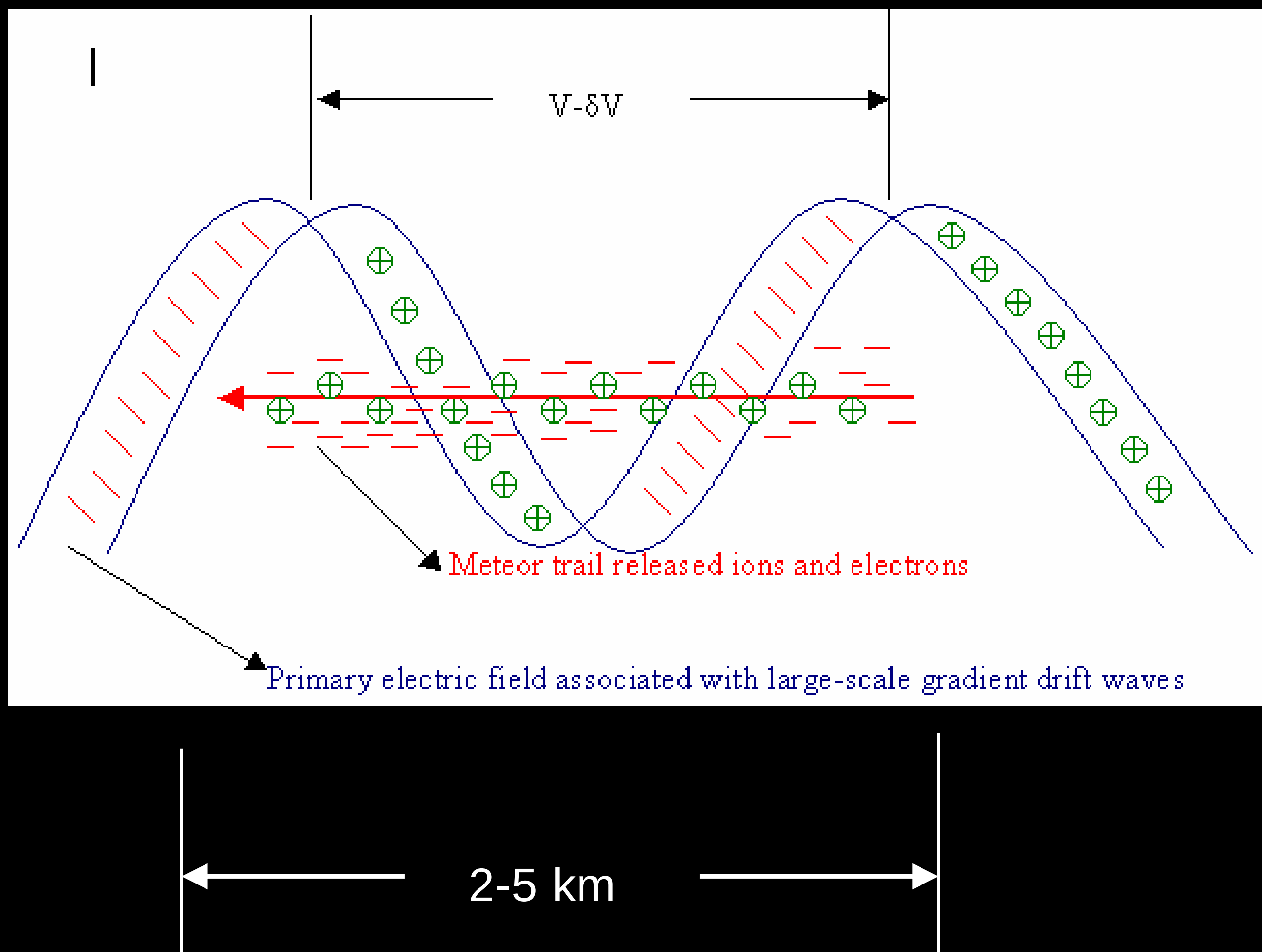
Spectral Width Vs Mean Doppler frequency Characteristics Corresponding to the Event

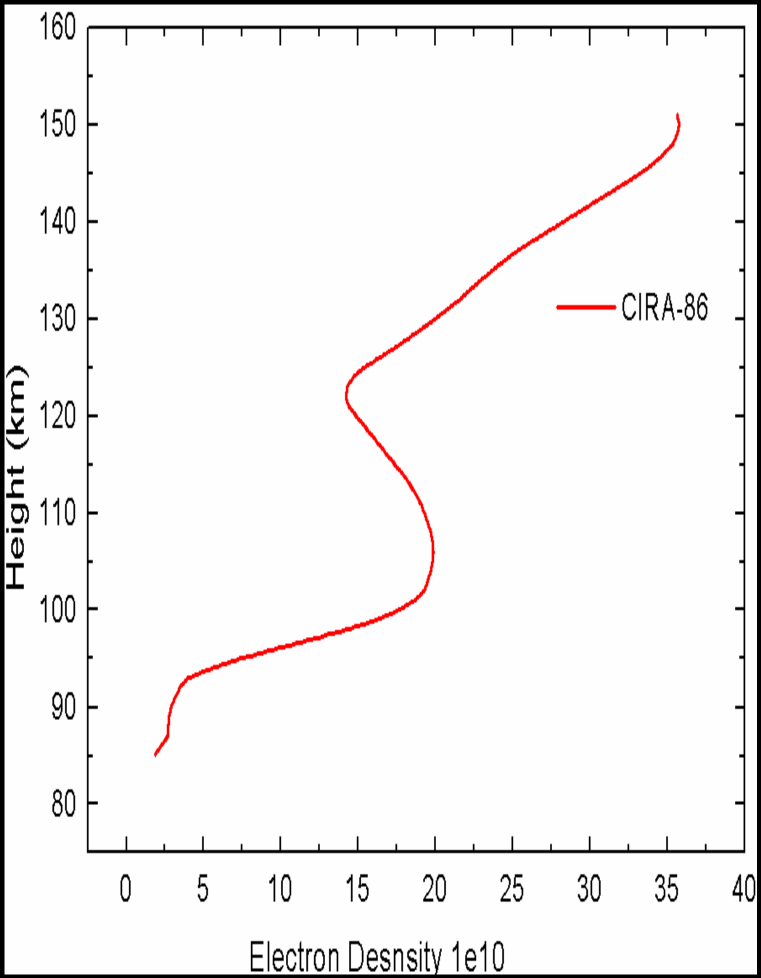


Key parameters

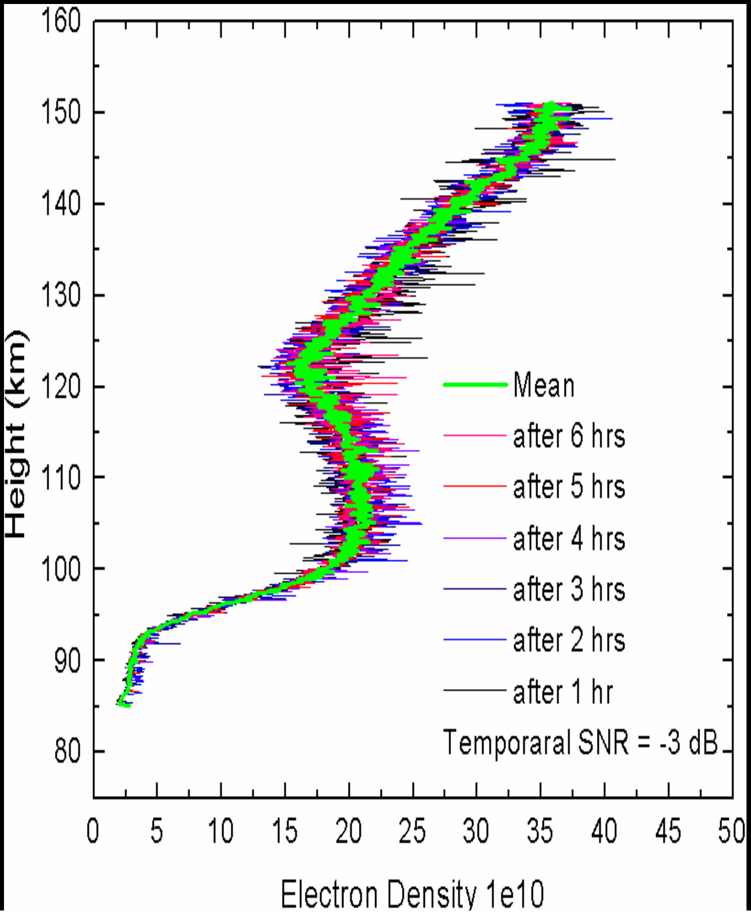
- Weakening of Electric field or Electron density gradient
- OR weakening of both

Trail released ions and electrons redistribute themselves according to the primary electric filed



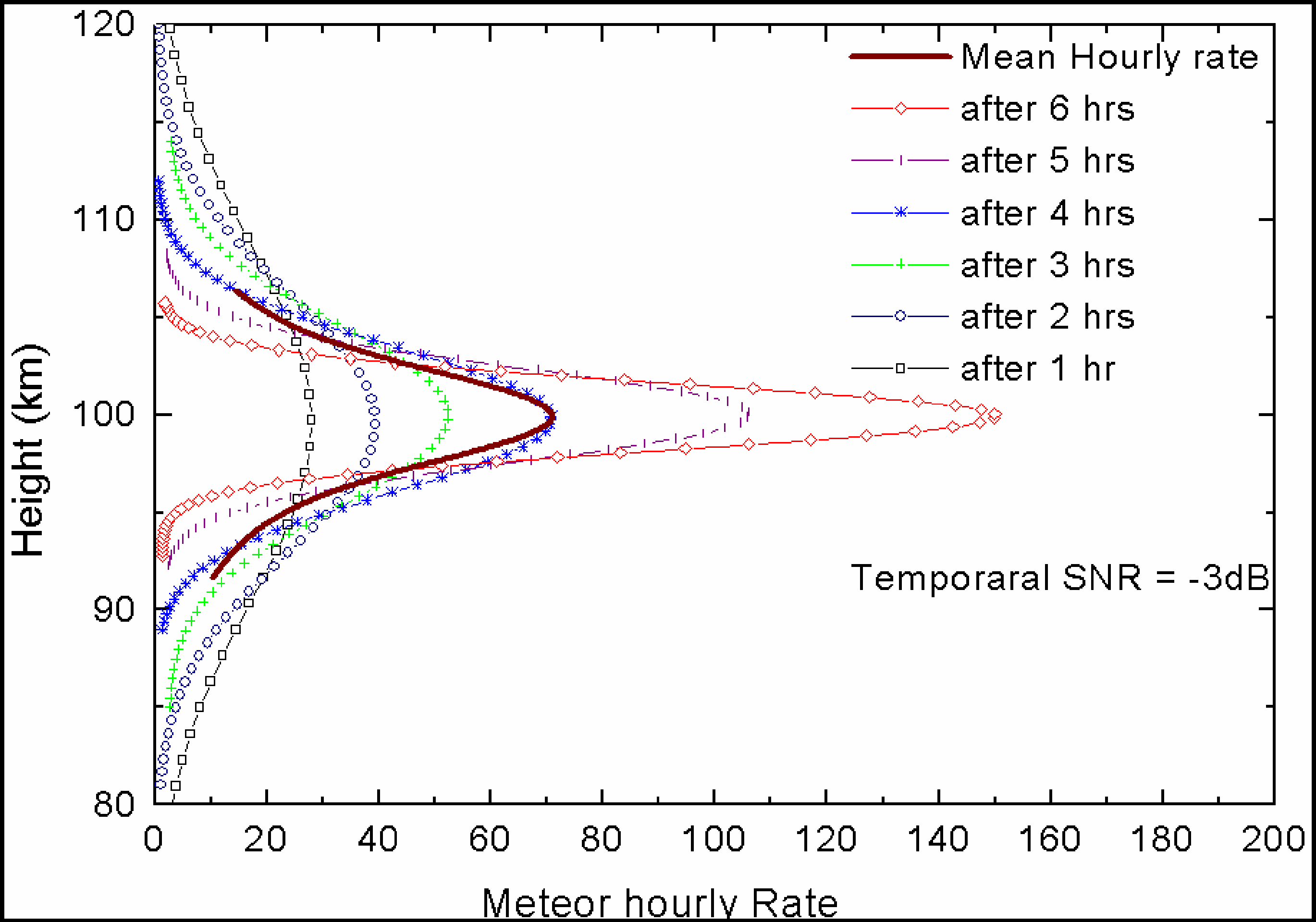


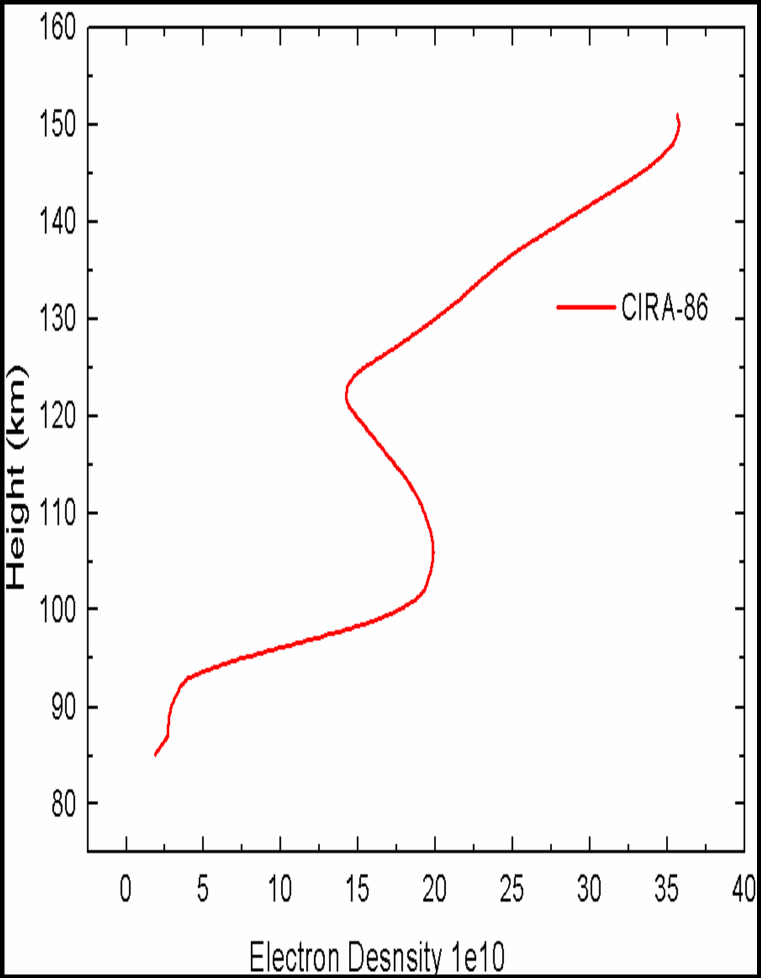
Electron Density CIRA-86



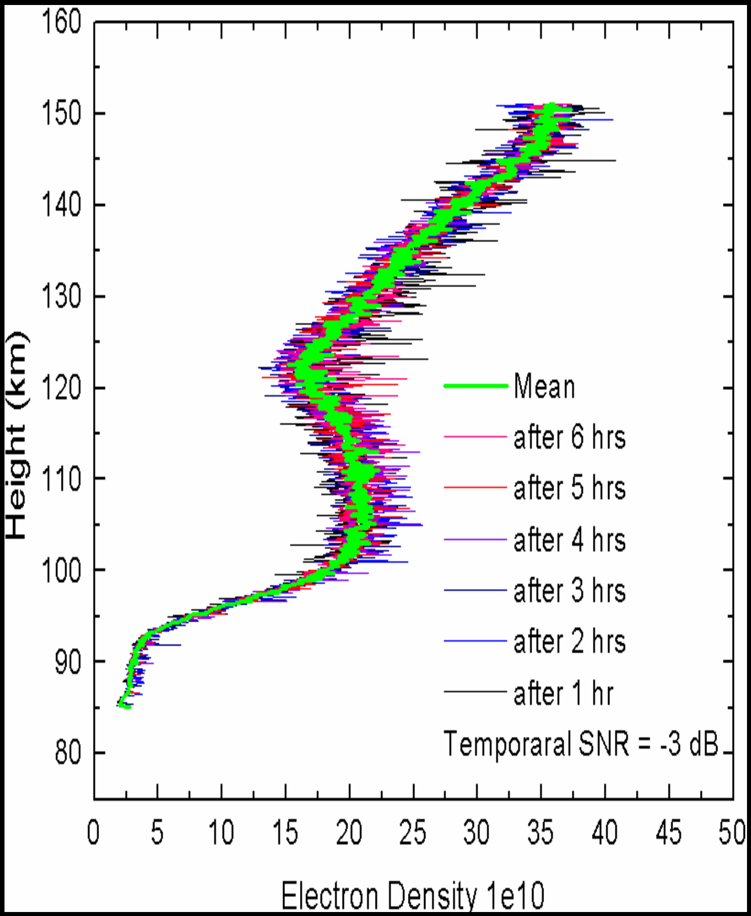
Simulated Gaussian Electron density Fluctuations With Height and Time

Simulated Vertical Gaussian Distribution of Penetration of Meteor trails



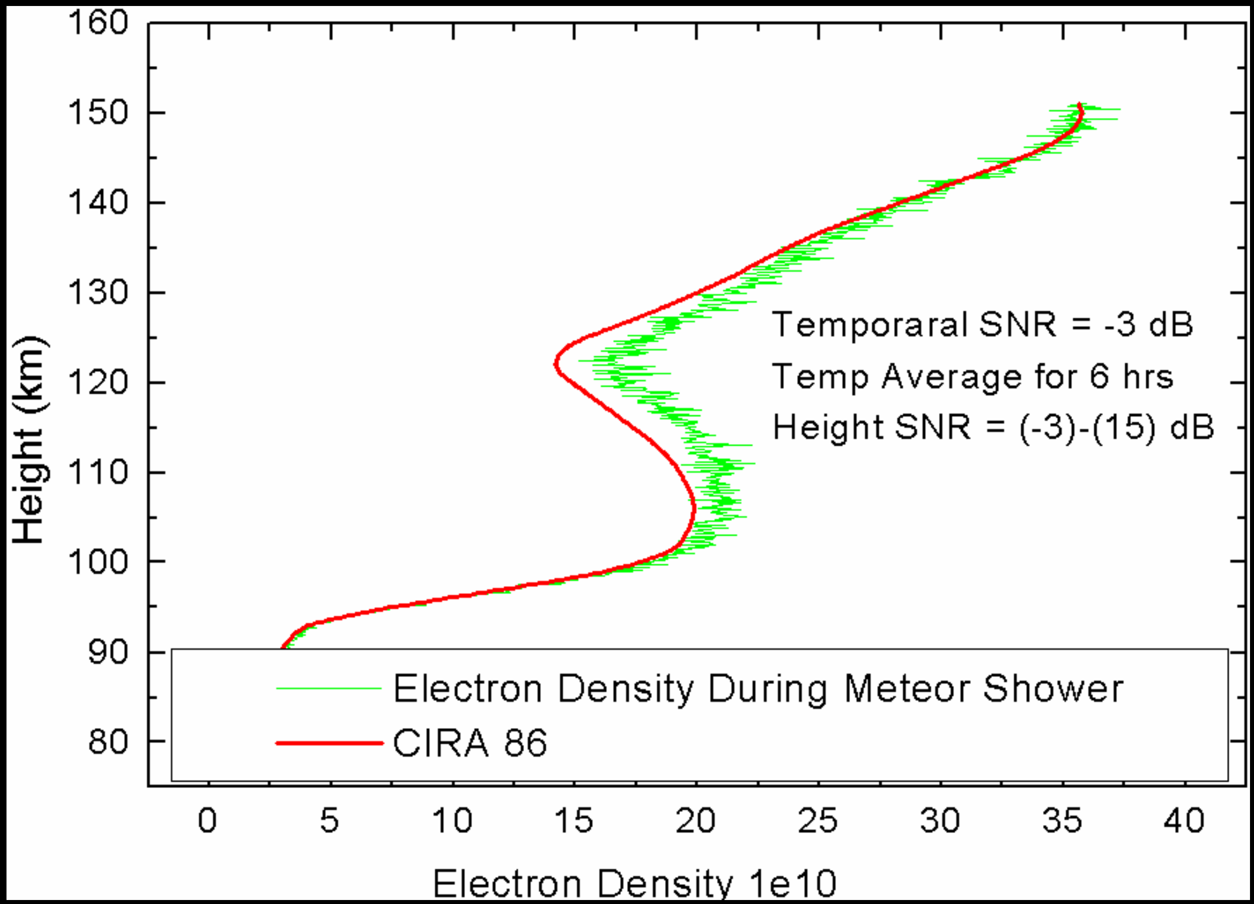


Electron Density CIRA-86



Simulated Gaussian Electron density Fluctuations With Height and Time

Composite effect of height and time Gaussian electron density fluctuations for the shower period



Results

- Redistribution of Trail generated electrons and ions with respect to the local electric field seem to have strong influence on FAI by decreasing the electric fields.
- The electron density fine structures with height appears to get smooth out as the meteor shower introduce a few hundred to few thousands of meteors per hour.

First Results on Lightning Experiment Conducted Over Gadanki Using Indian MST Radar

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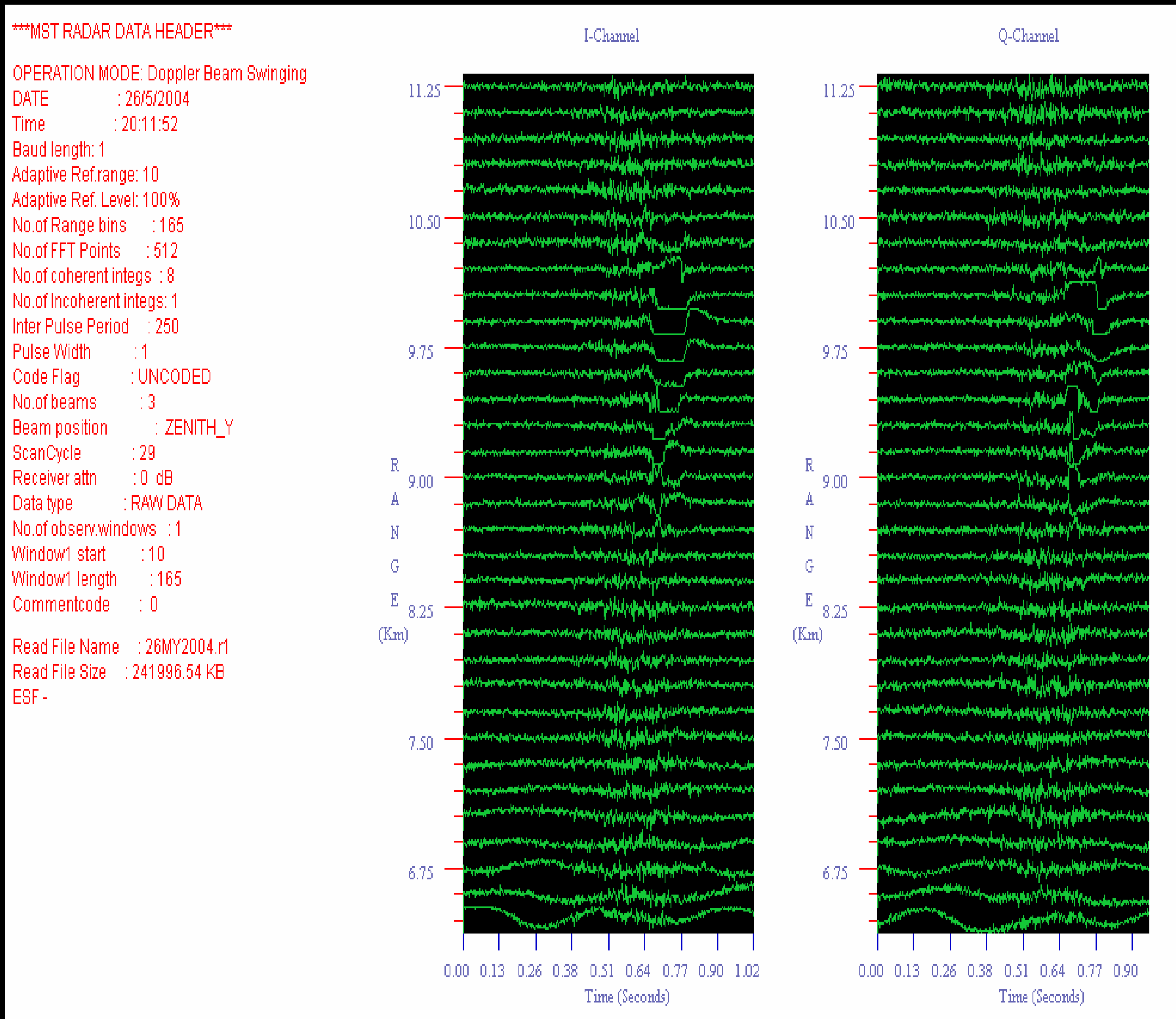
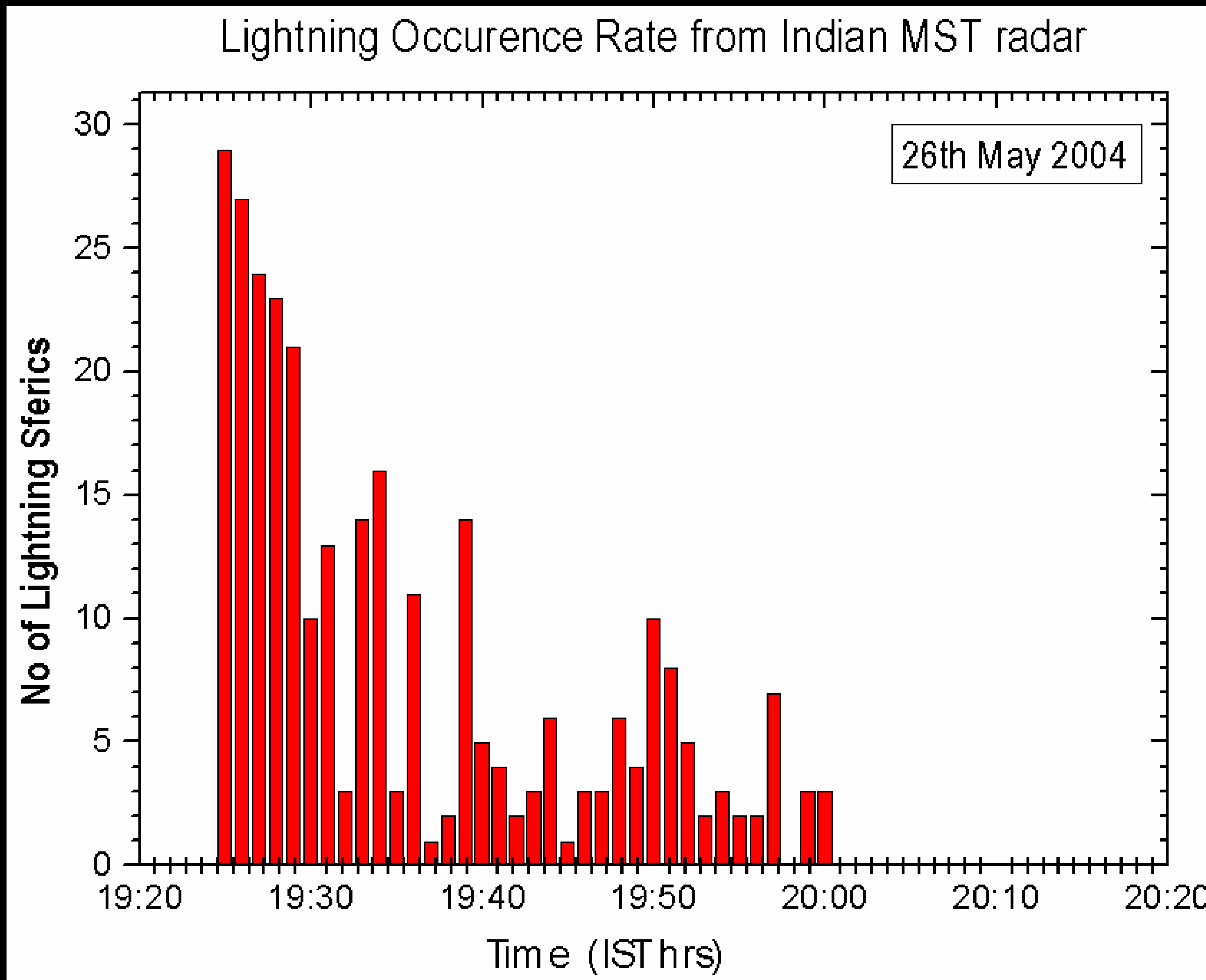
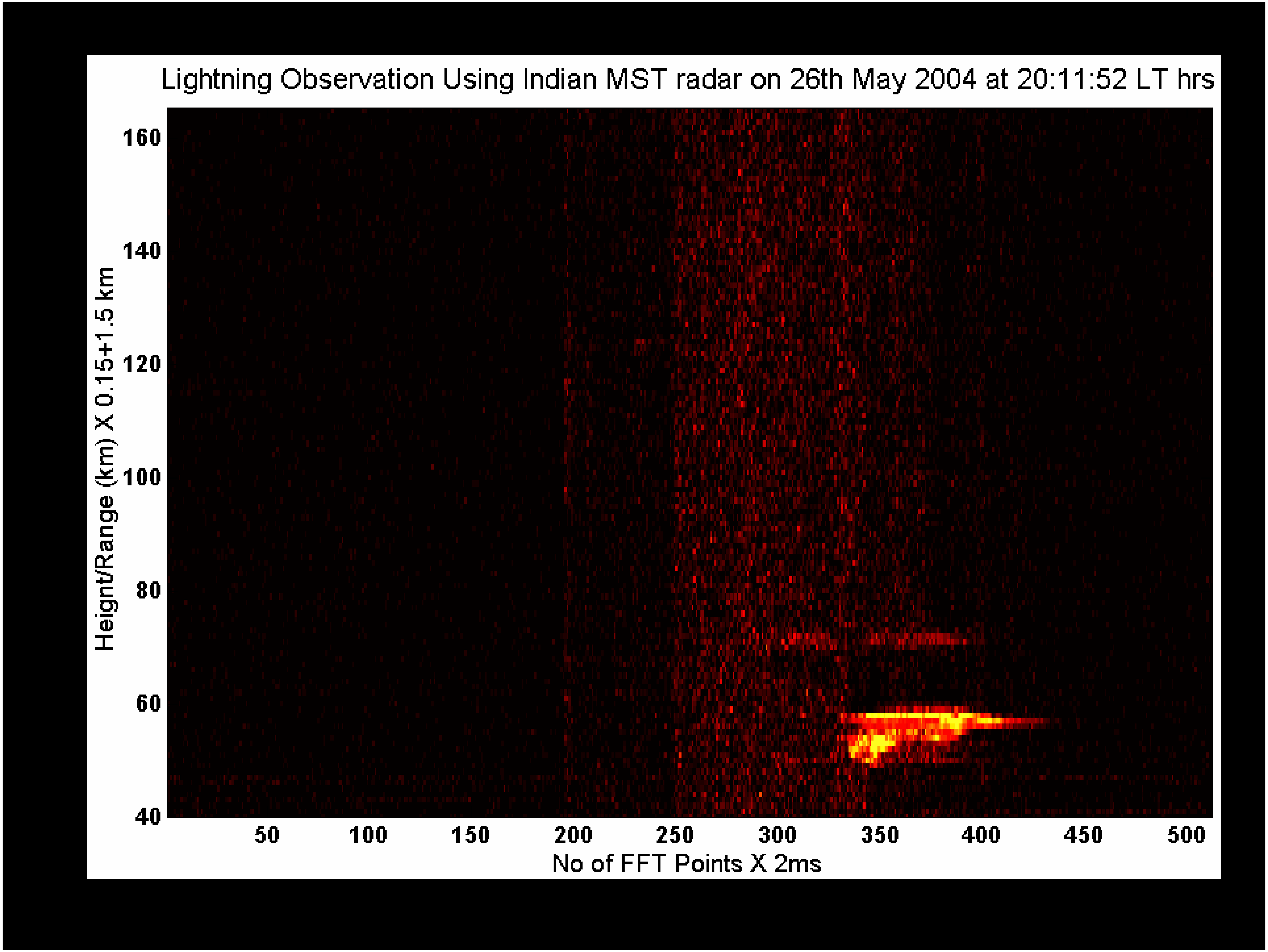
Panvel, Navi Mumbai, India – 410 218
2 National MST Radar Facility, PB No 123, Tirupati, AP, India
3 Jicamarca radar Peru

MST radar Raw data obtained during Lightning



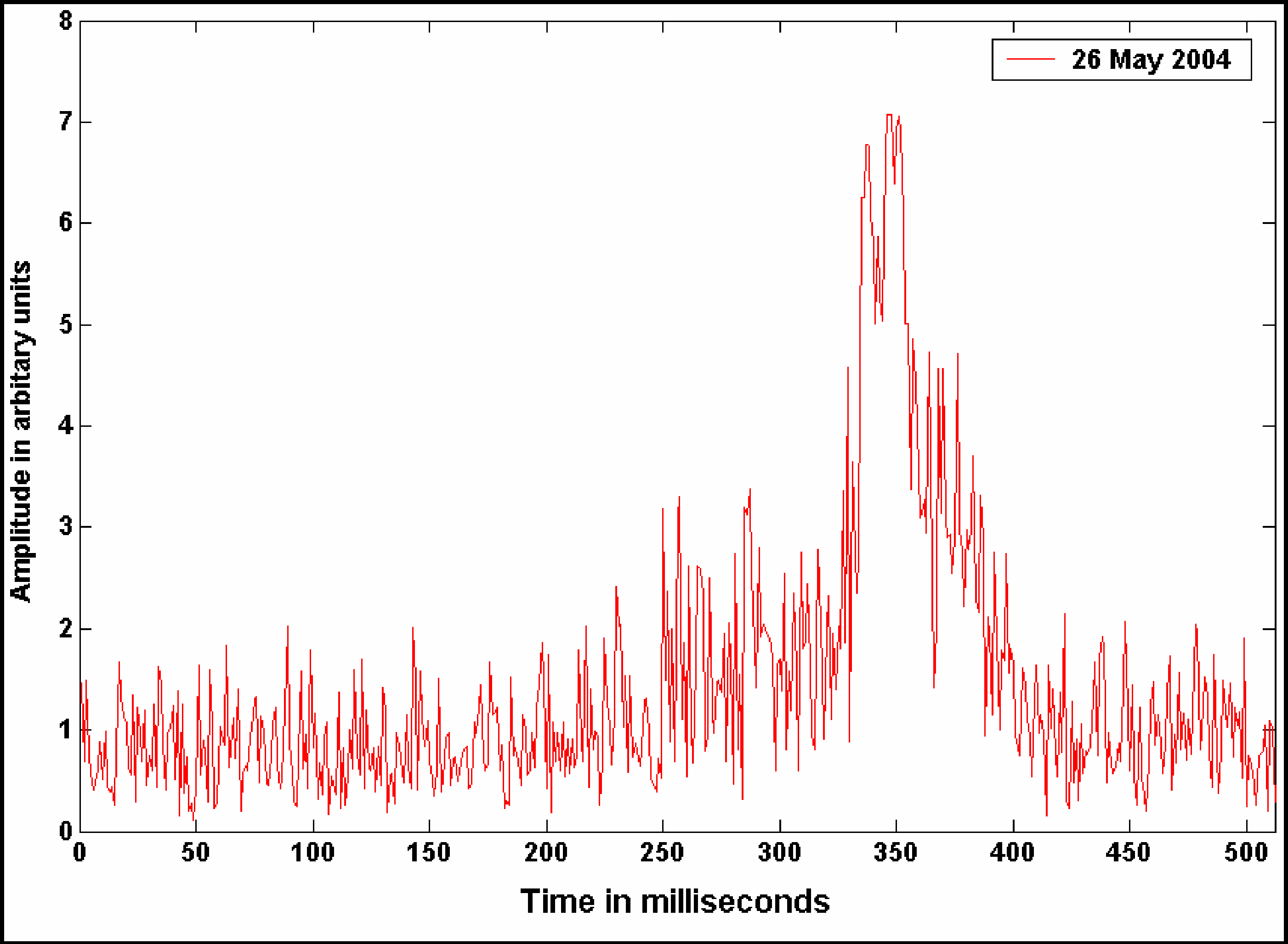


Lightning Occurence Rate from Indian MST radar
26th May 2004
No of Lightning Sferics
0
5
10
15
20
25
30
19:20
19:30
19:40
19:50
20:00
20:10
20:20
Time (IST hrs)

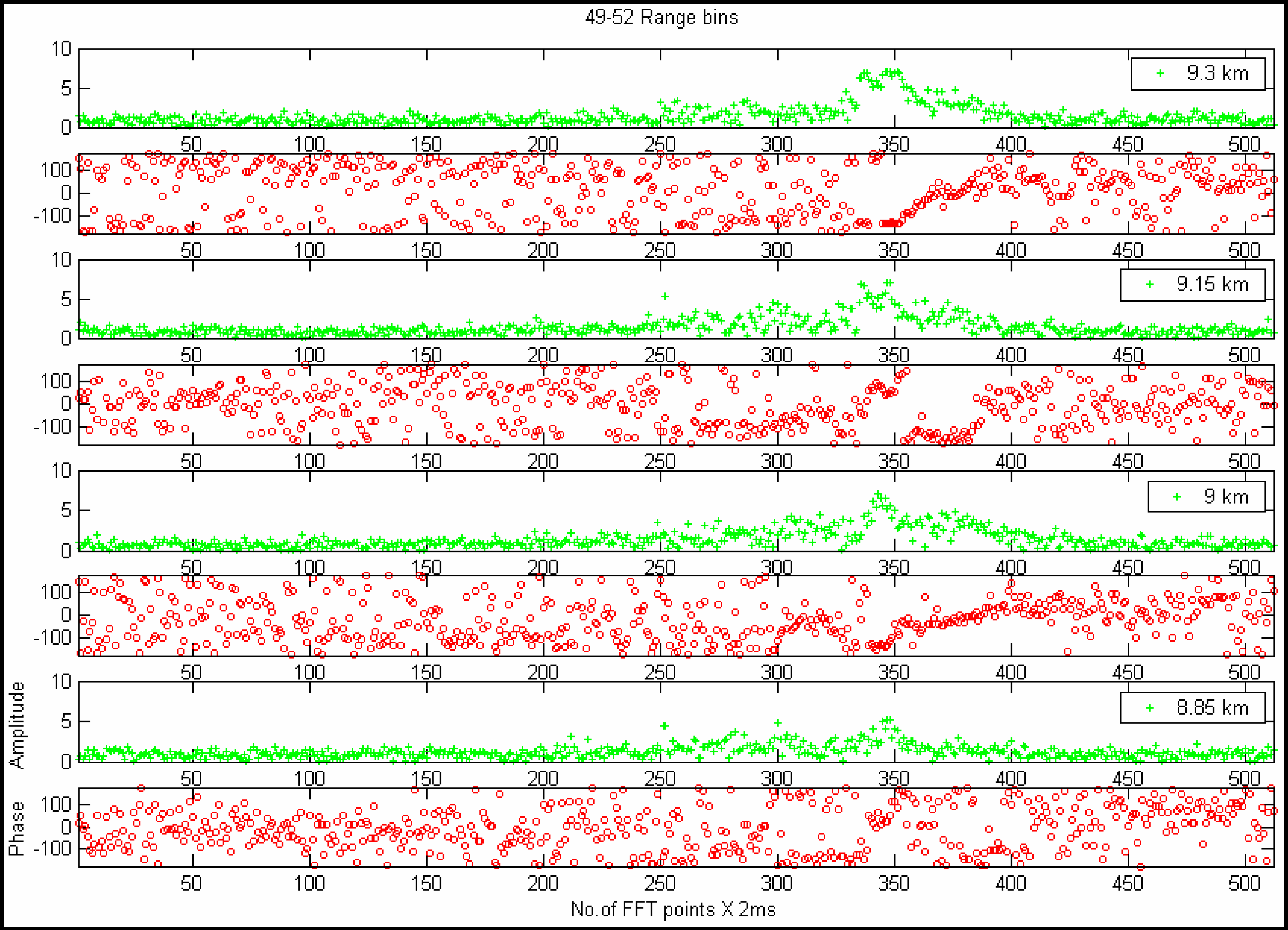


Lightning Observation Using Indian MST radar on 26th May 2004 at 20:11:52 LT hrs
Height/Range (km) X 0.15+1.5 km
40
60
80
100
120
140
160
50
100
150
200
250
300
350
400
450
500
No of FFT Points X 2ms

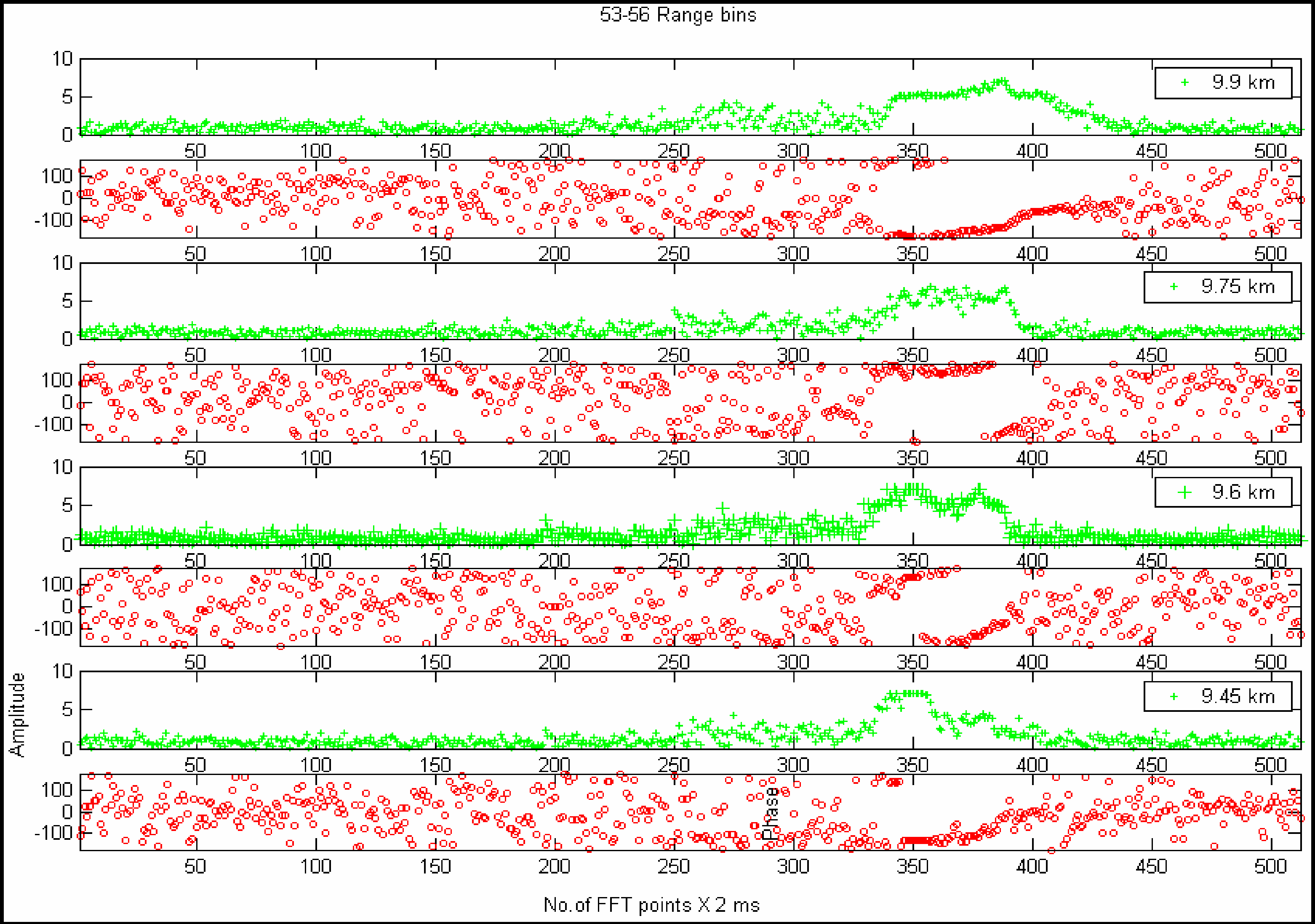
Lightning Echo Amplitude Characteristics



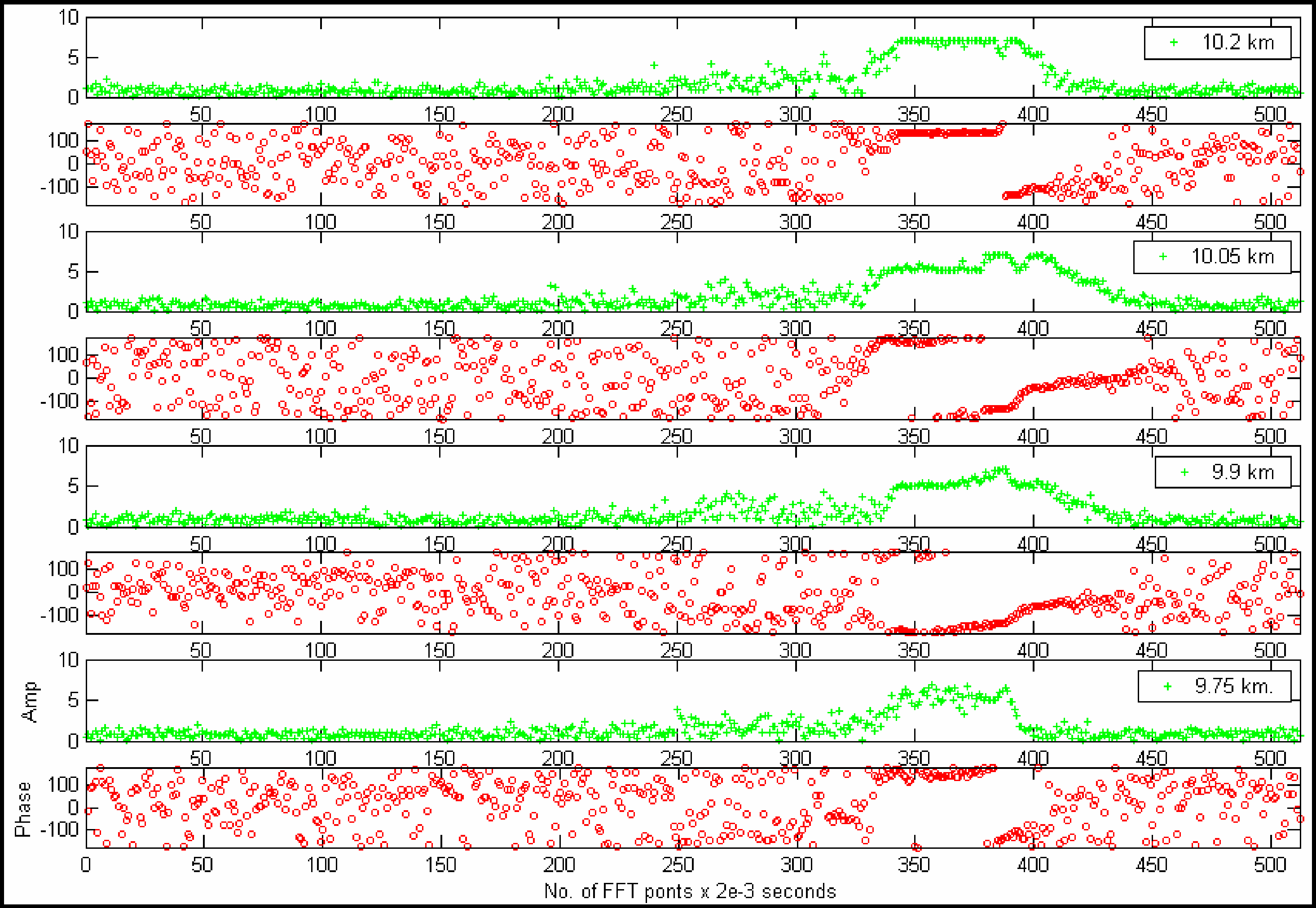
Phase and Amplitude records corresponding to the Lightning

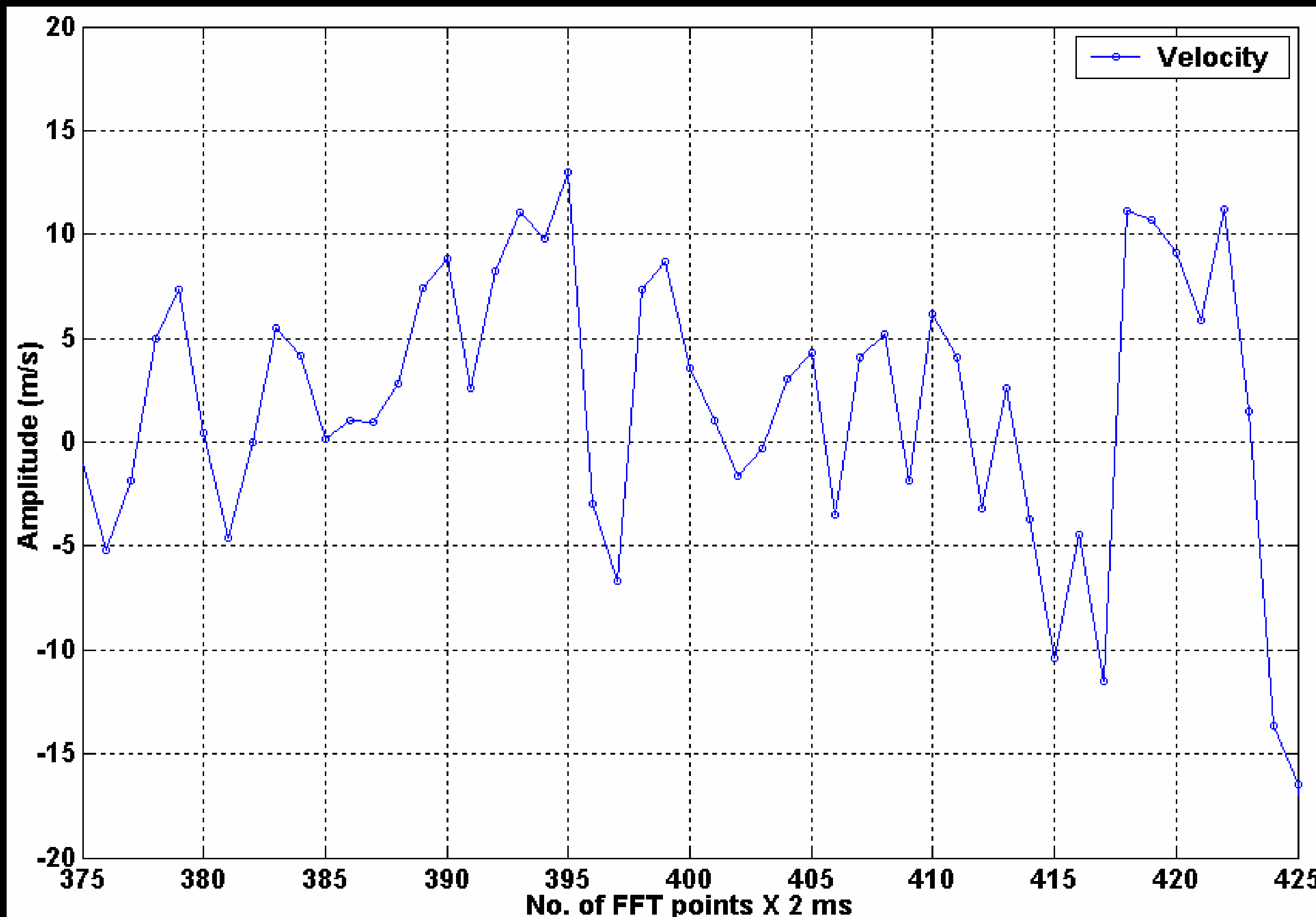


Phase and Amplitude records corresponding to the Lightning



Phase and Amplitude records corresponding to the Lightning





Velocity
Amplitude (m/s)
20
15
10
5
0
-5
-10
-15
-20
375
380
385
390
395
400
405
410
415
420
425
No. of FFT points X 2 ms

Some of the Characteristics of Lightning as observed with the MST radar

There were at least three types of echoes observed with the following characteristics

- There was always a small increase in the sferics followed by a transient raise of intense sferics almost at all the ranges
- Echoes well separated in range transiently raising in power only at their respective ranges
- There was a well-defined echo traversing down in range with decreasing intensity with time and range.
- The jumps in phase progress indicate that the echo center changes rapidly with the development of lightning channels

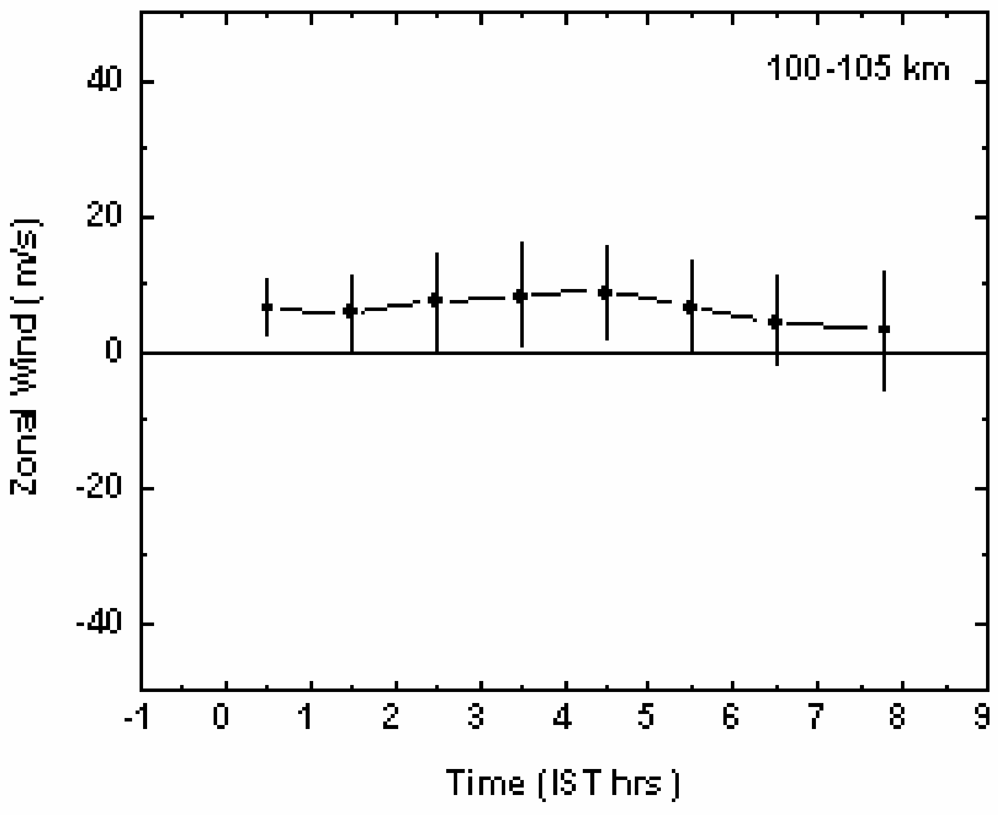
Perhaps these echoes differ because of the type they belong to such as intera-cloud, cloud-cloud and cloud-ground. However, further investigation to be made with the help of careful collection of raw data for these kinds of events to understand these echoes in a better manner.

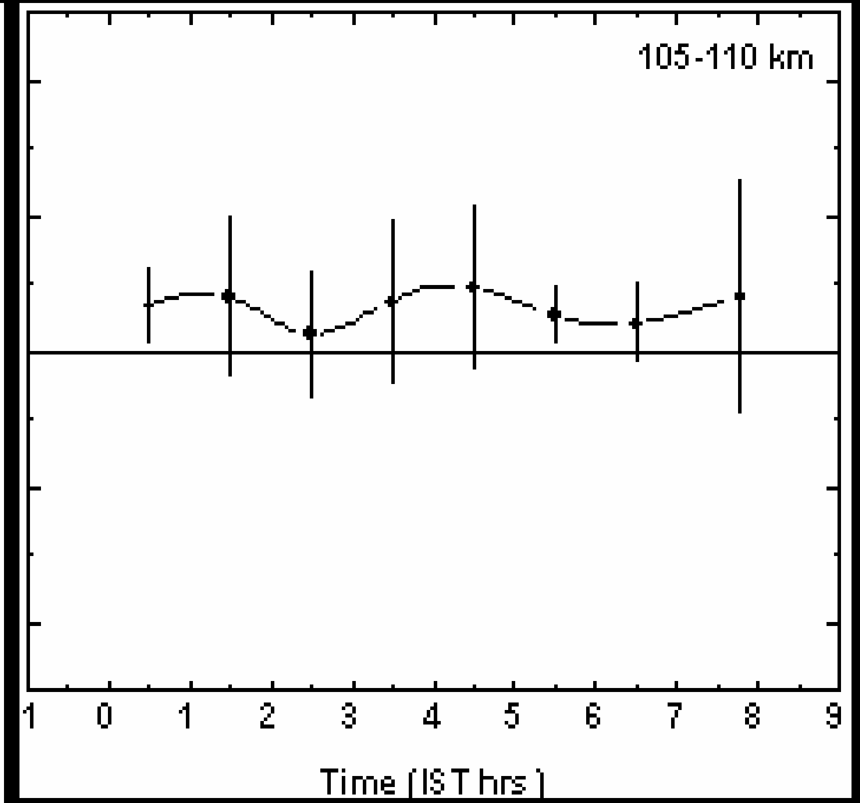
Abstract - II

MLT winds , waves, and its periods

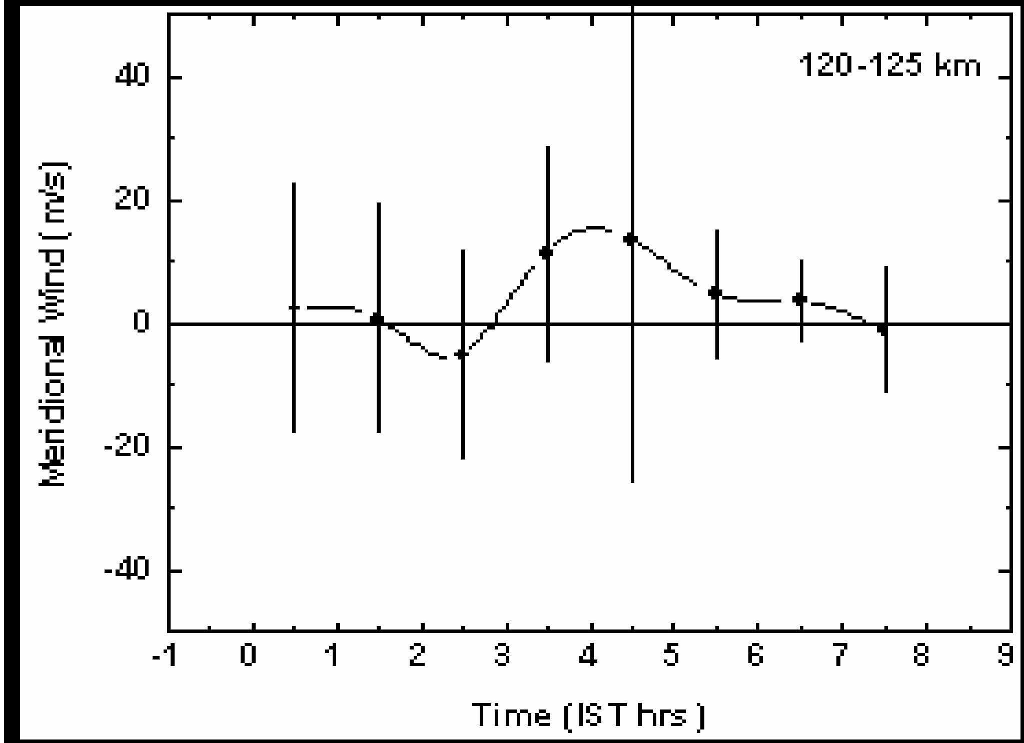
MLT winds

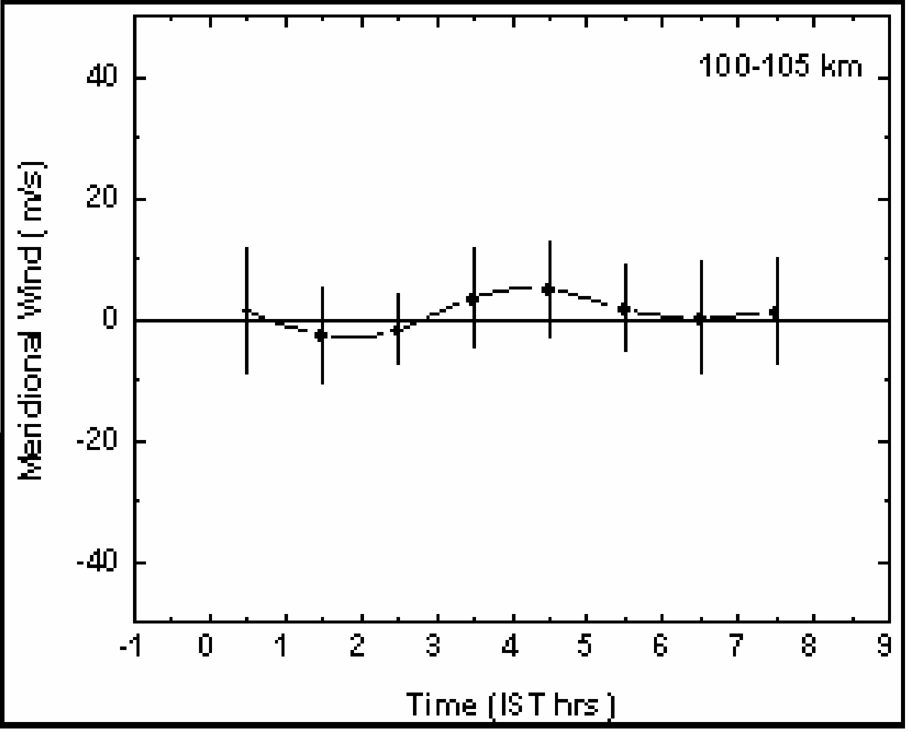
- Local Time Vs Zonal Wind



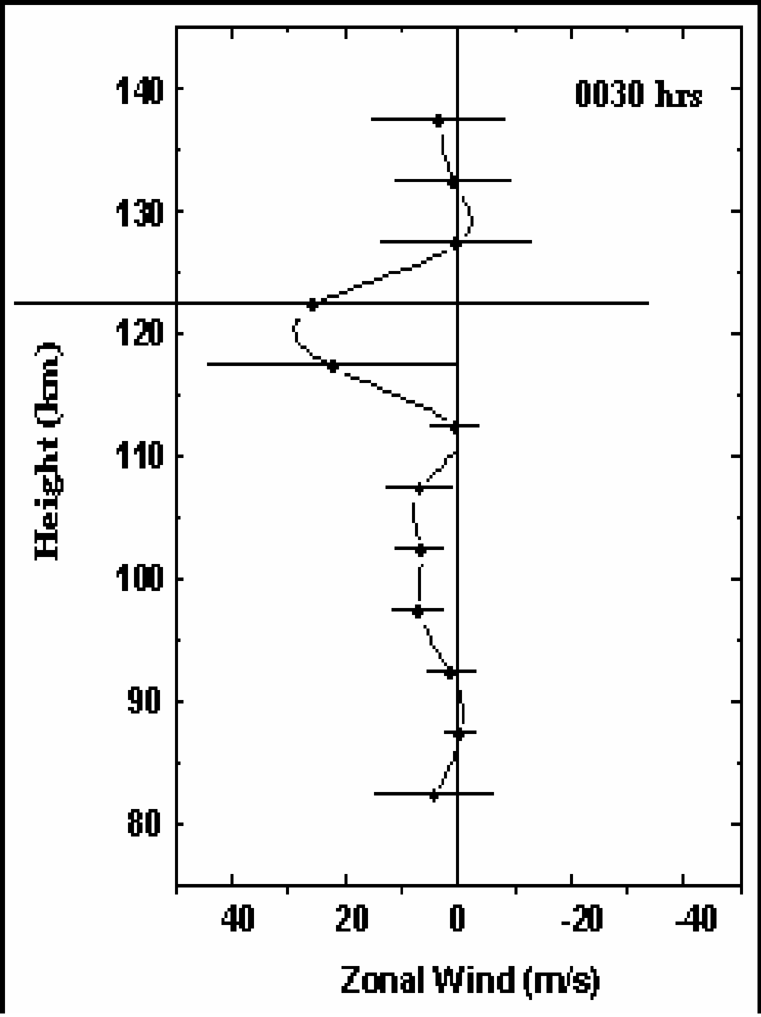


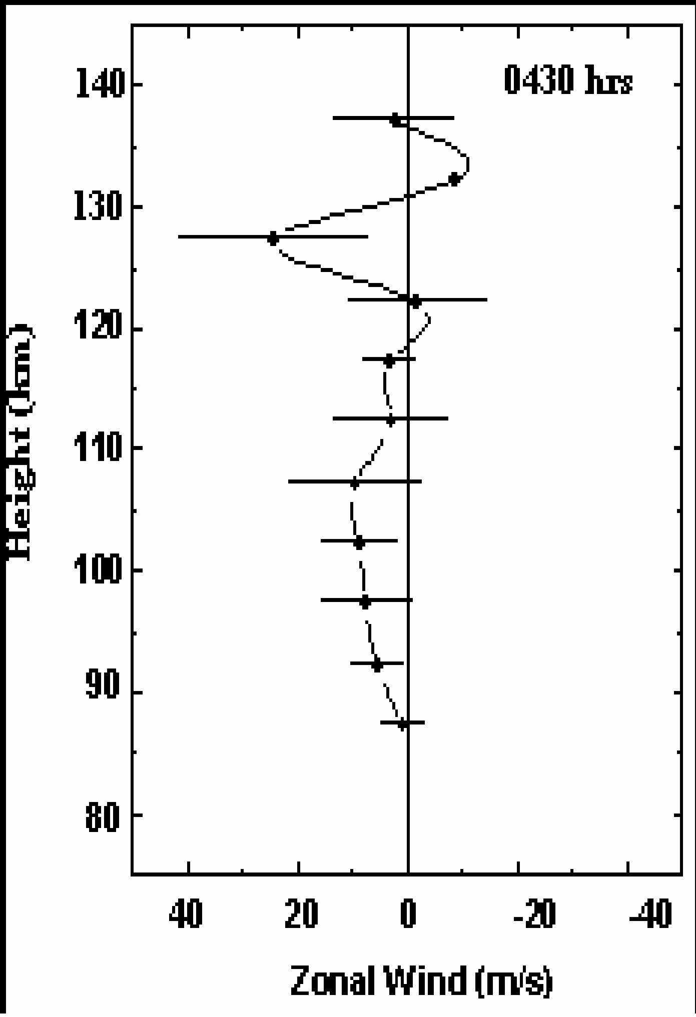
➢Local Time Vs Meridional Wind



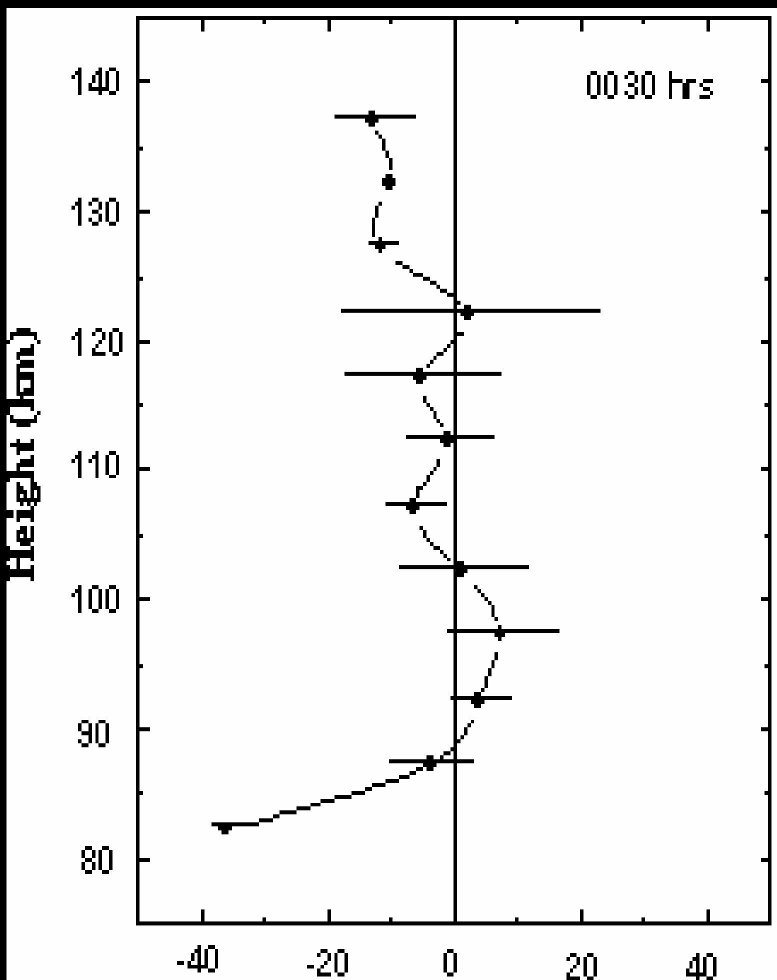


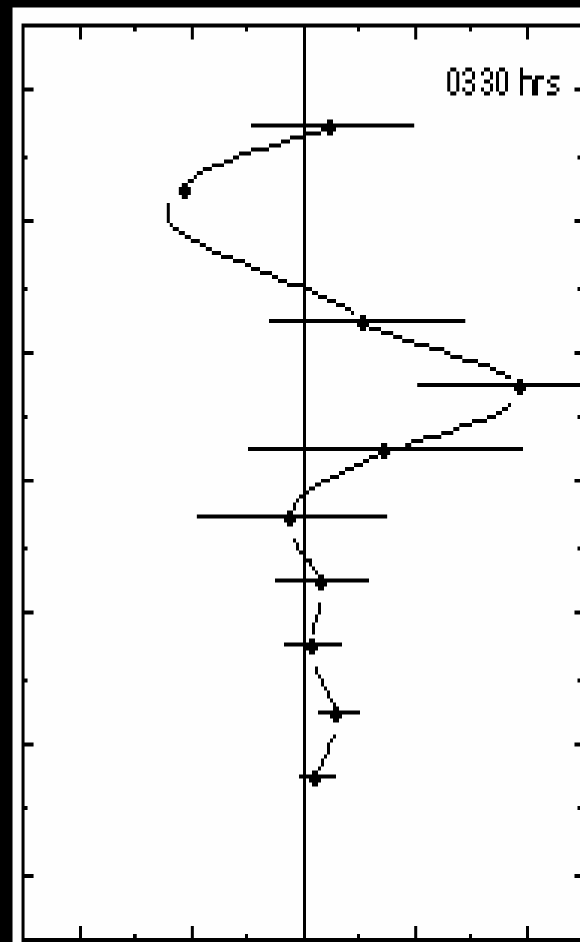
Height Vs Zonal Wind



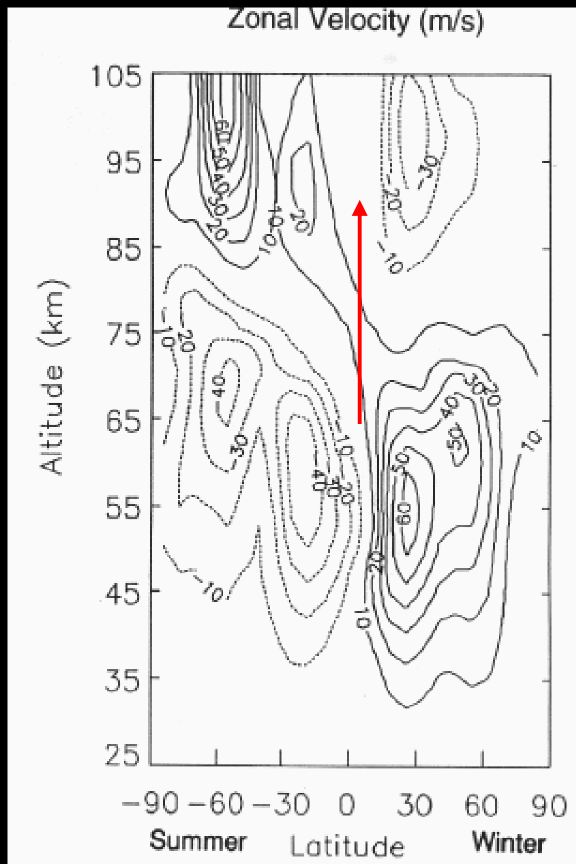


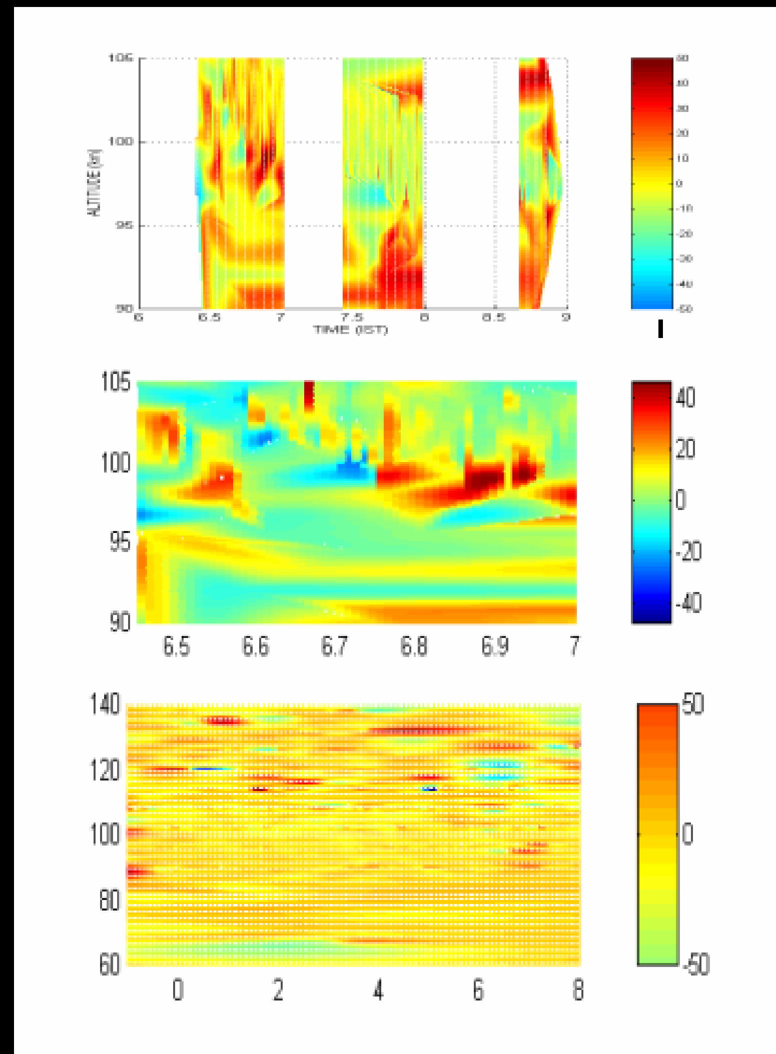
Height Vs Meridional Wind





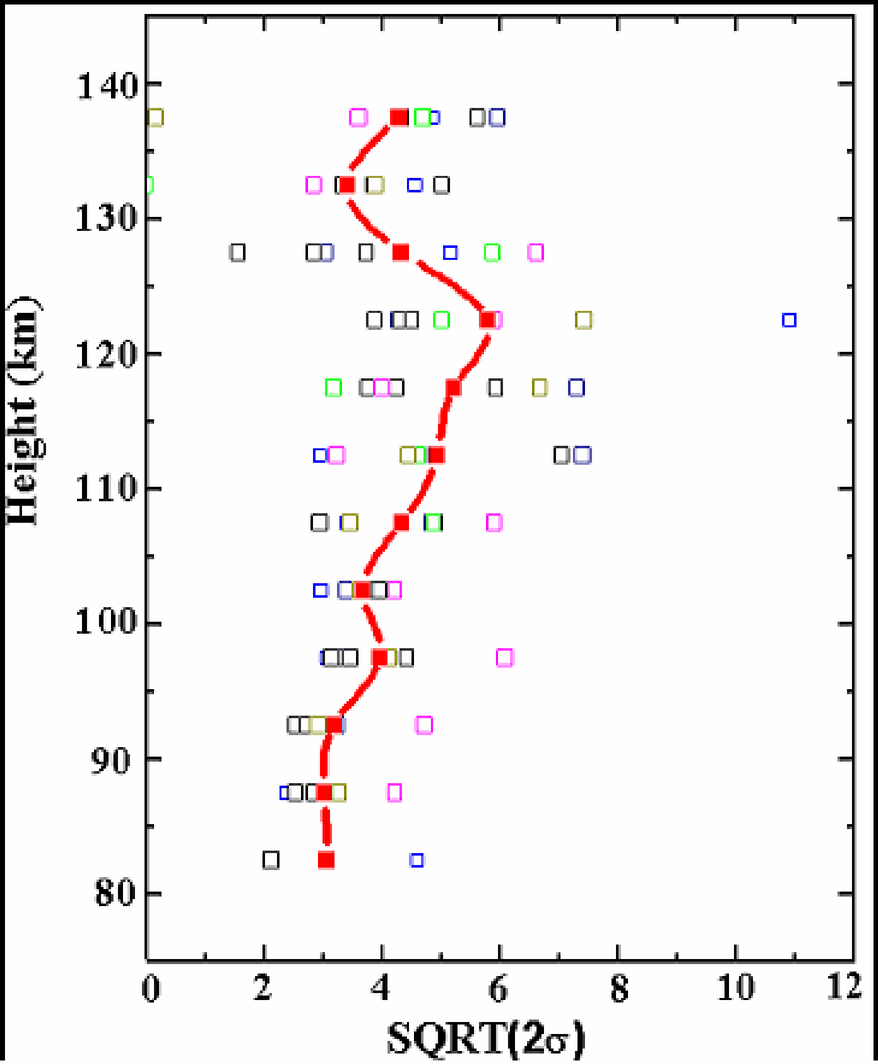
Zonal Wind during Sep and Dec 2001 representing Equinox and Winter

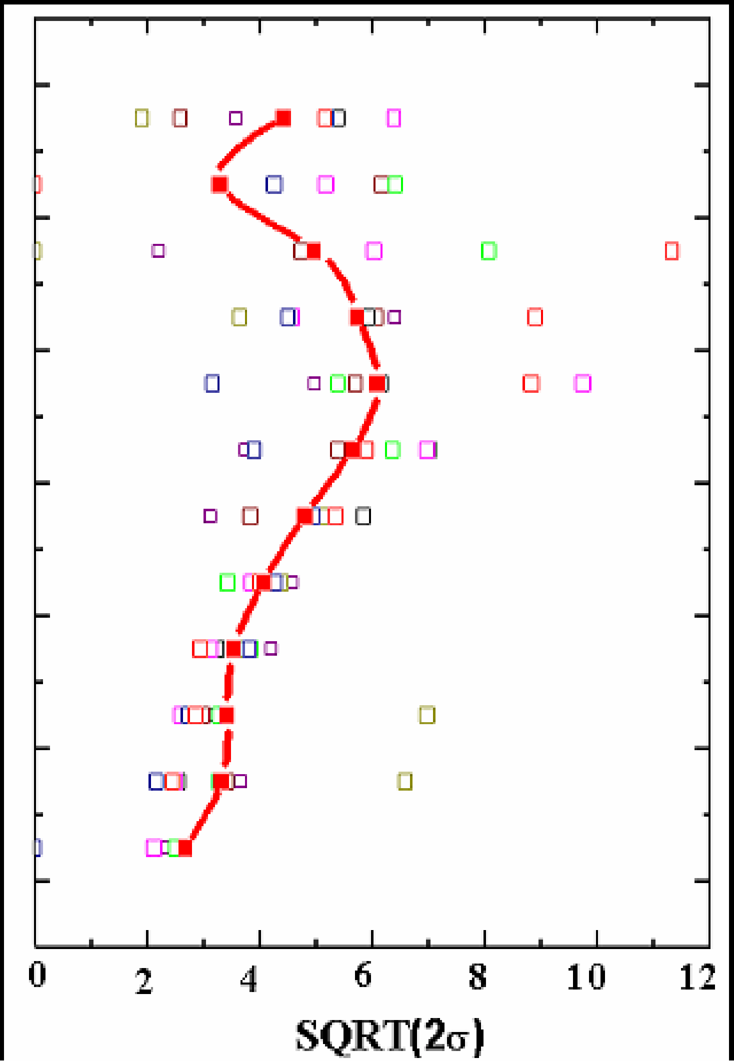




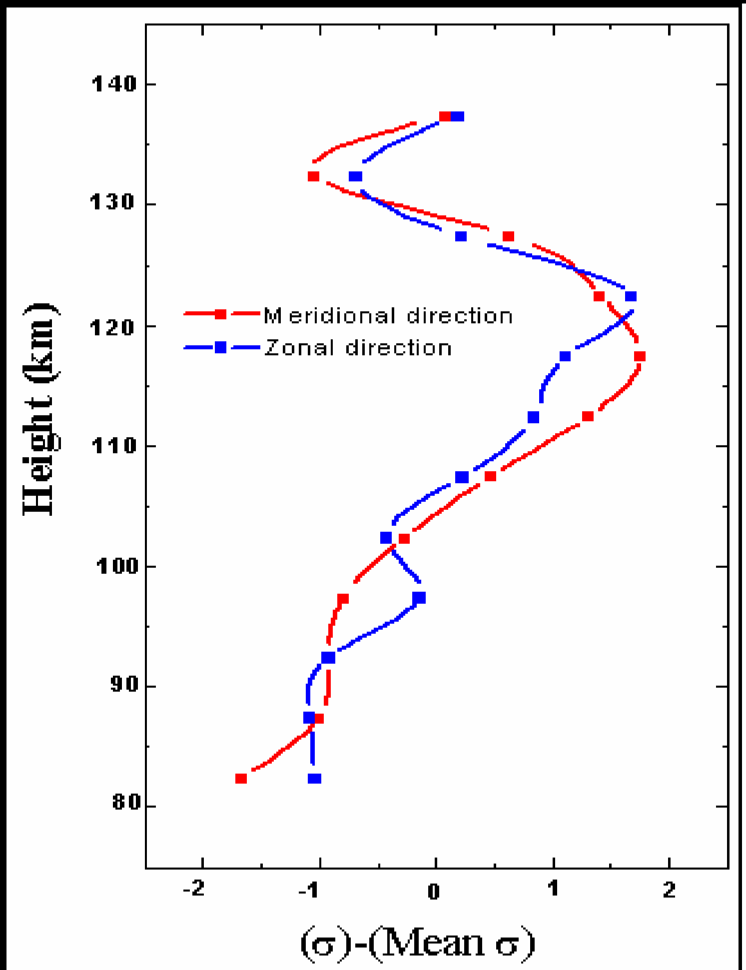
Courtesy PI: Hans G. Mayr, NASA
Goddard Space Flight Center, Greenbelt,
MD 20771

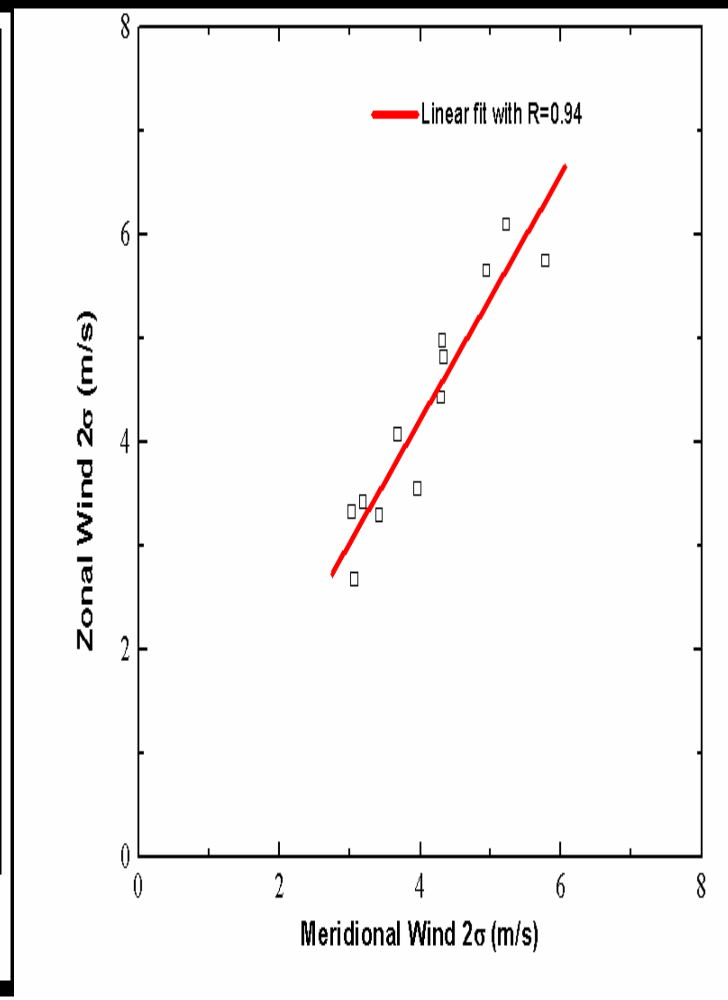
Wind Variance
Zonal and Meridional Direction





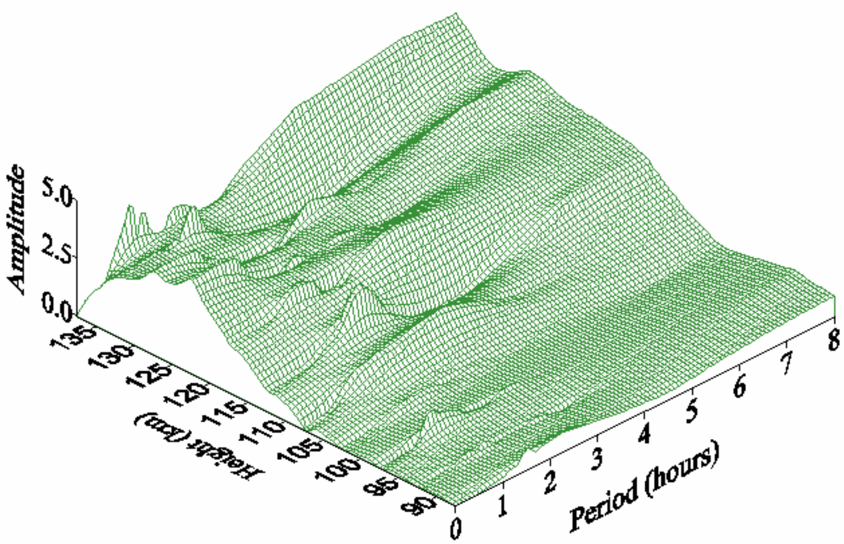
Zonal wind Vs Meridional Wind Variance



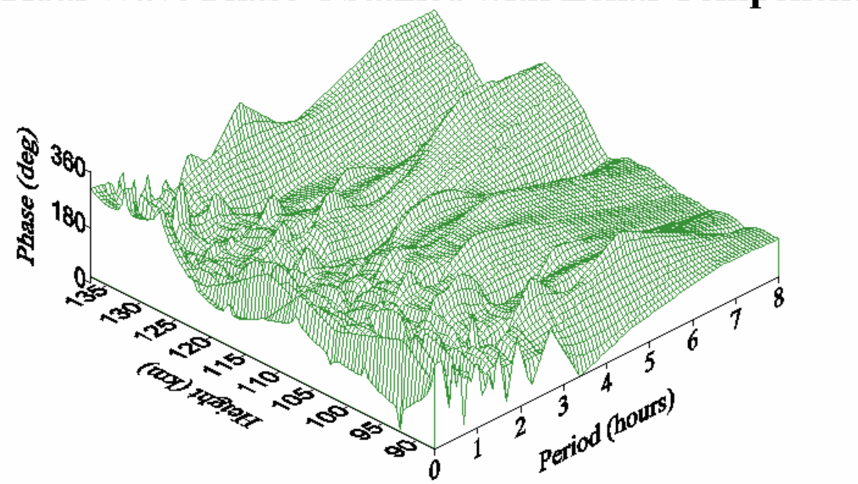


Gravity wave periods found with Zonal wind

Tidal Wave Amplitudes in Zonal Wind component

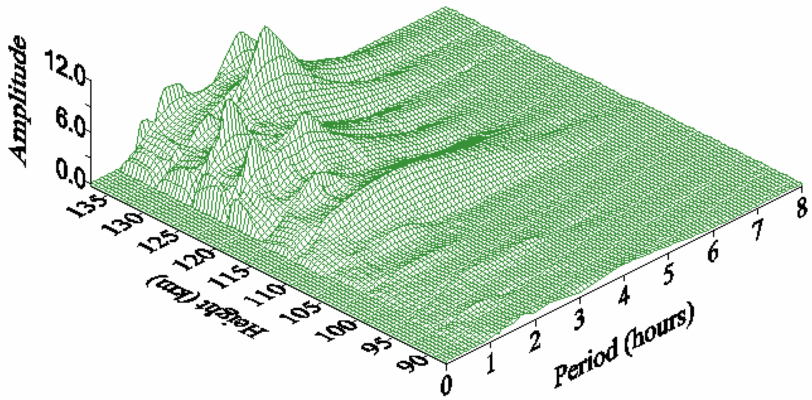


Tidal Wave Phase Obtained with Zonal Component

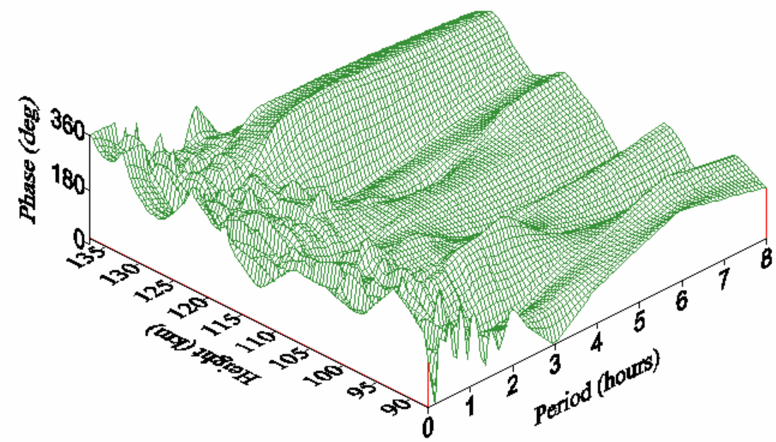


Gravity wave periods found with Meridional Wind

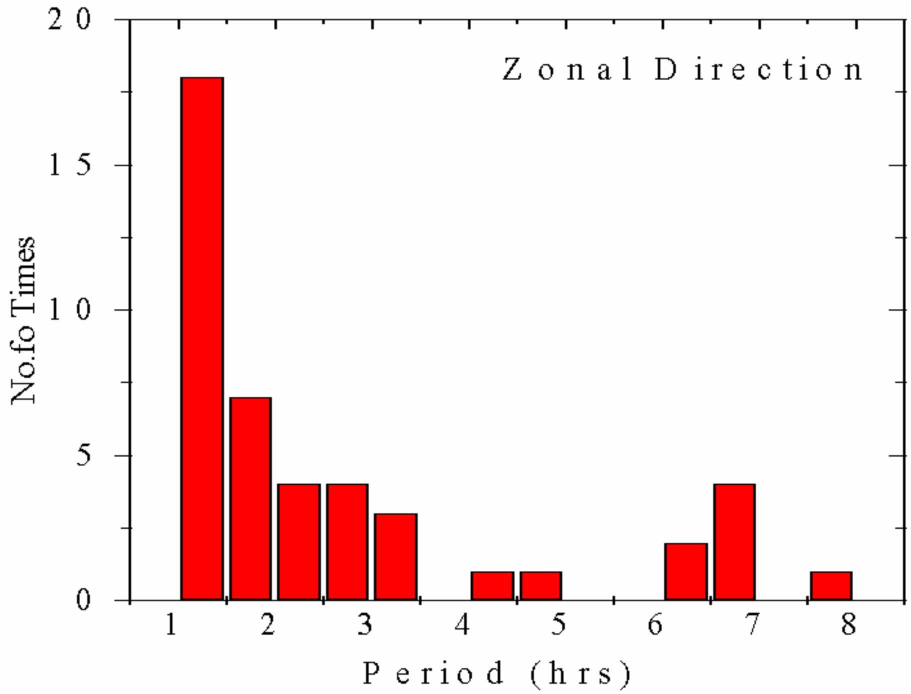
Tidal Wave Amplitudes in Meridional Component

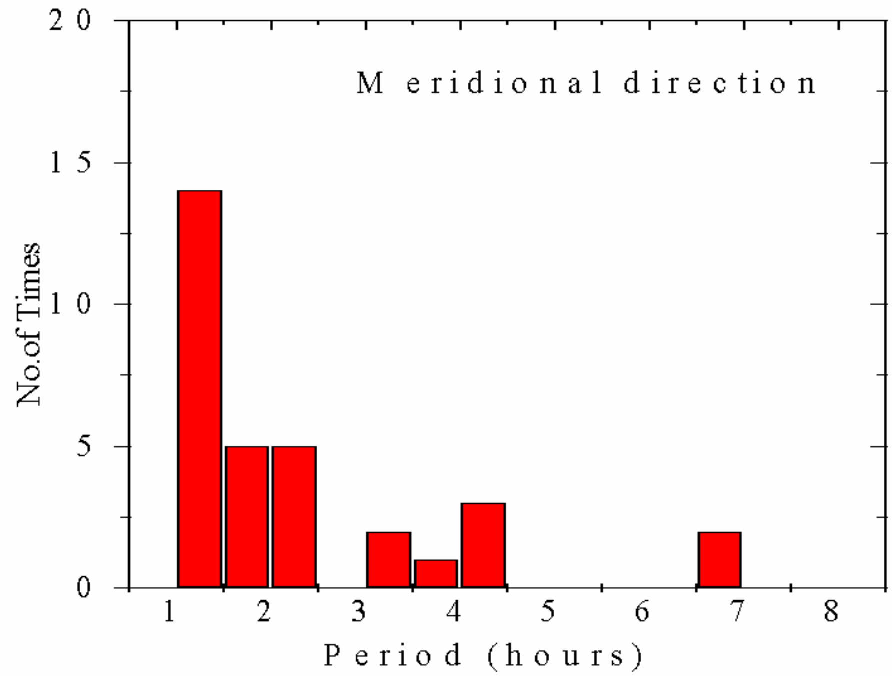


Tidal Wave Phase Observed with Meridional Component



Relative Occurrence of Gravity wave periods





Results

Intense radiant of Geominid meteor shower transit over north of Gadanki between 0200-0500 LT.

There are about ~20 underdense meteors per cubic kilometer volume per second.

tidal winds with the amplitudes ranging between ±20 ms^{-1} with a large vertical wavelength of about 40 km are revealed.

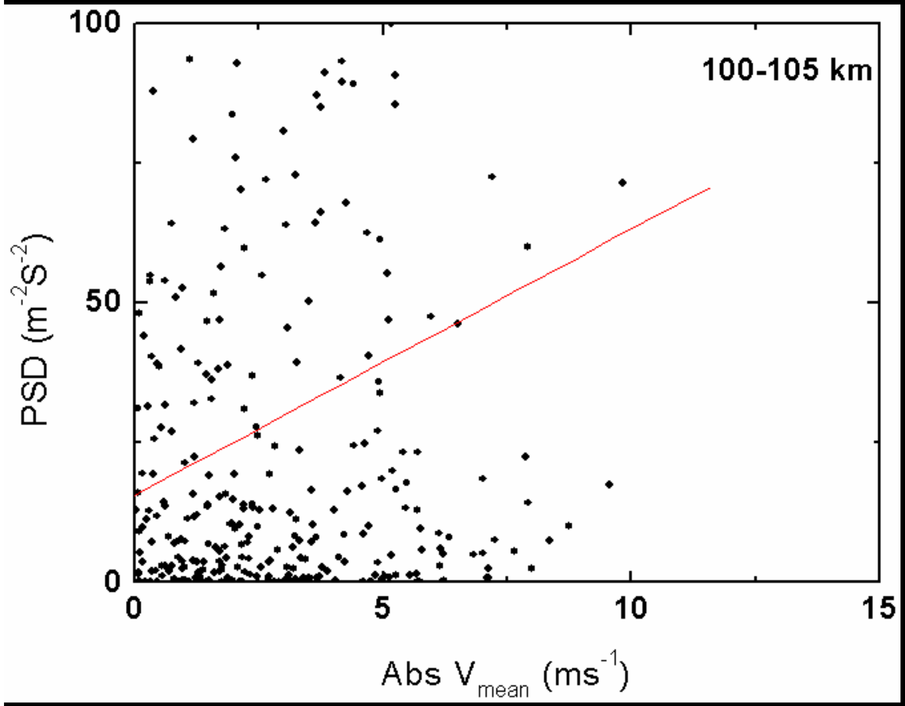
Periodicities are about 1.06, 2.37, 3.96 and 6.78 hours.

The histogram plotted using the table 1 &2 illustrates that gravity wave period below 3 hrs are common in both in zonal and meridional directions, the secondary peaks occur at 6.5-7.0 hrs and 4.0-4.5 hrs in the zonal and meridional directions respectively.

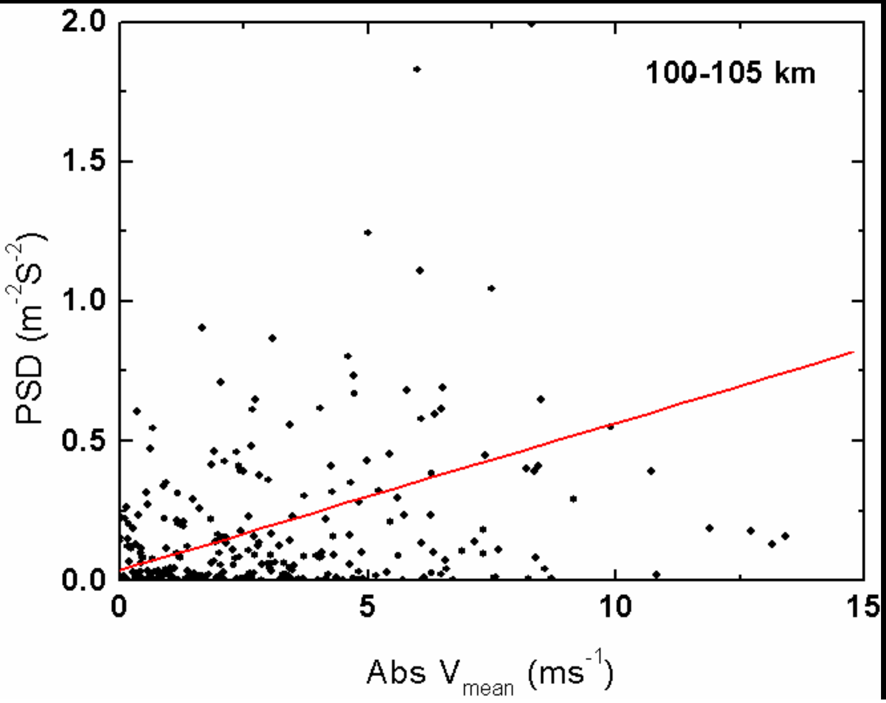
Abstract -III

- Short period Gravity waves (< 1 hr), Mean Wind Vs Power Spectral Densities, and Direction of Mean Wind.

PSD Vs Mean Wind

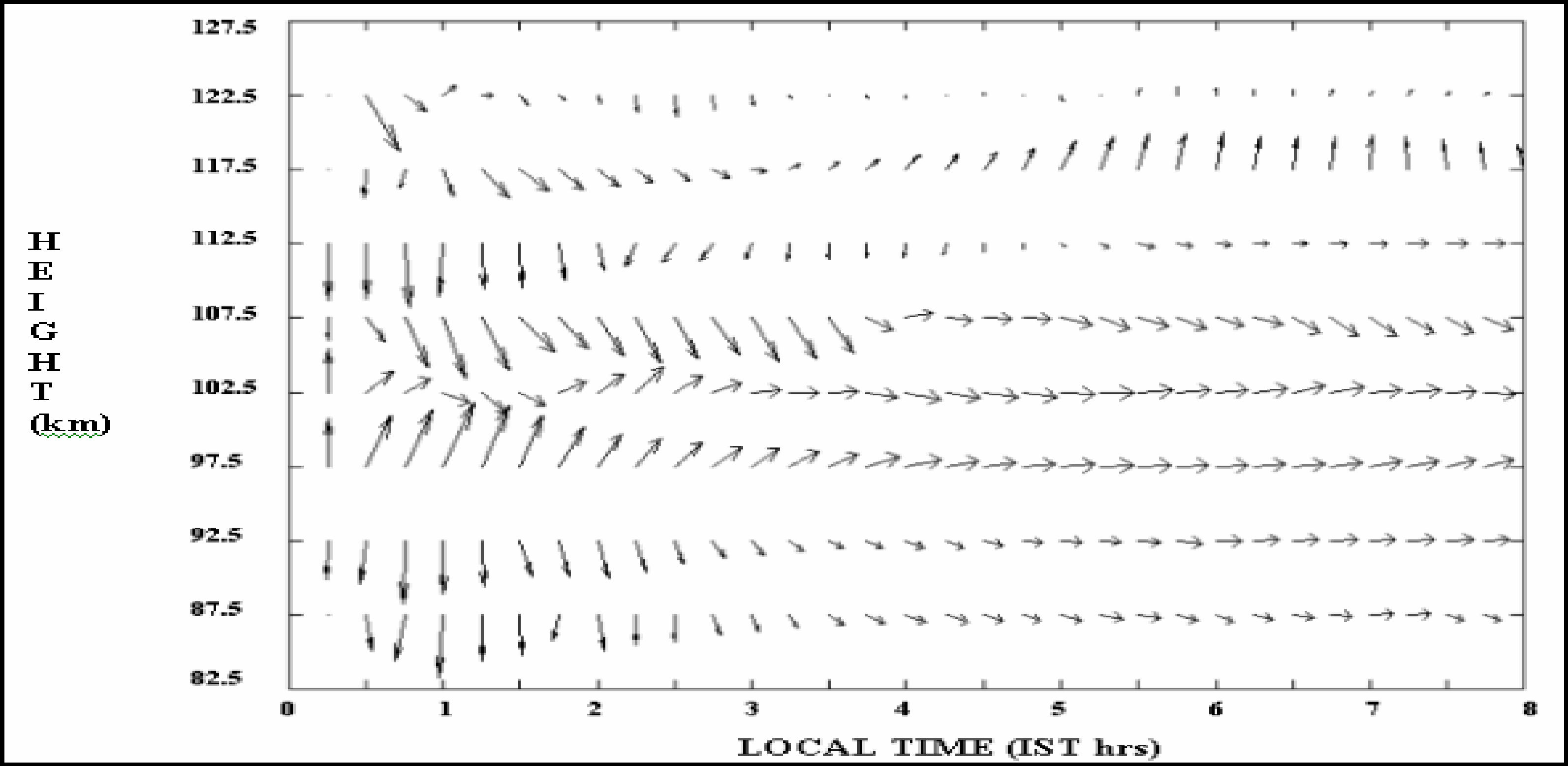


Meridional

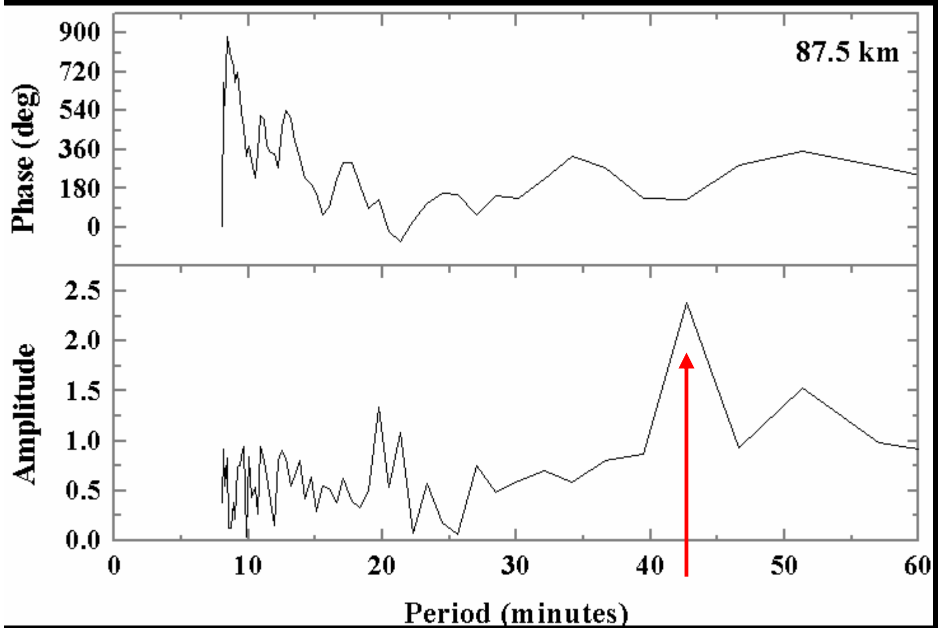


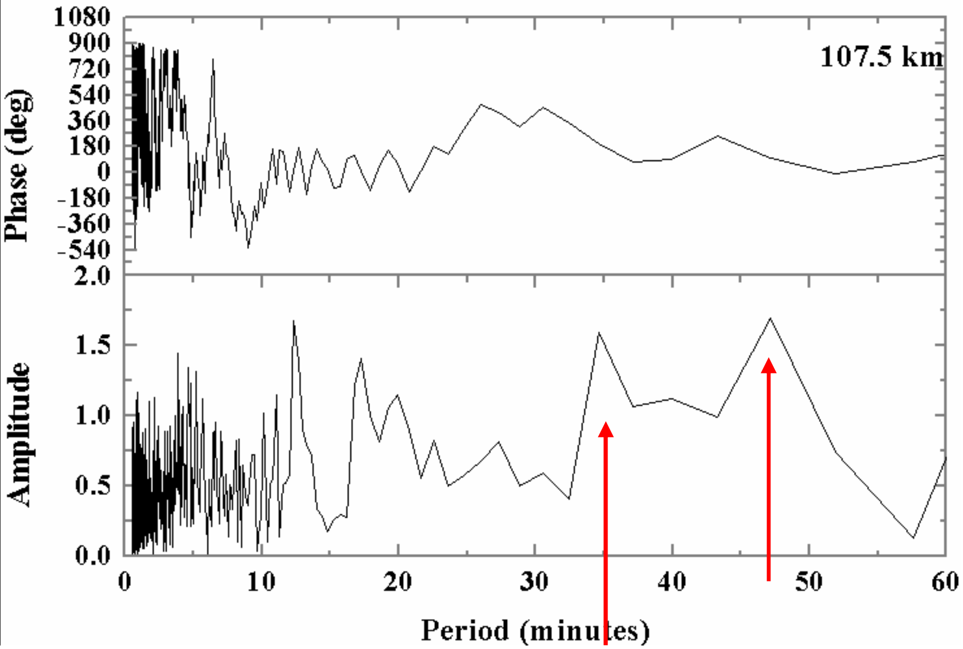
Zonal

Mean Wind Direction

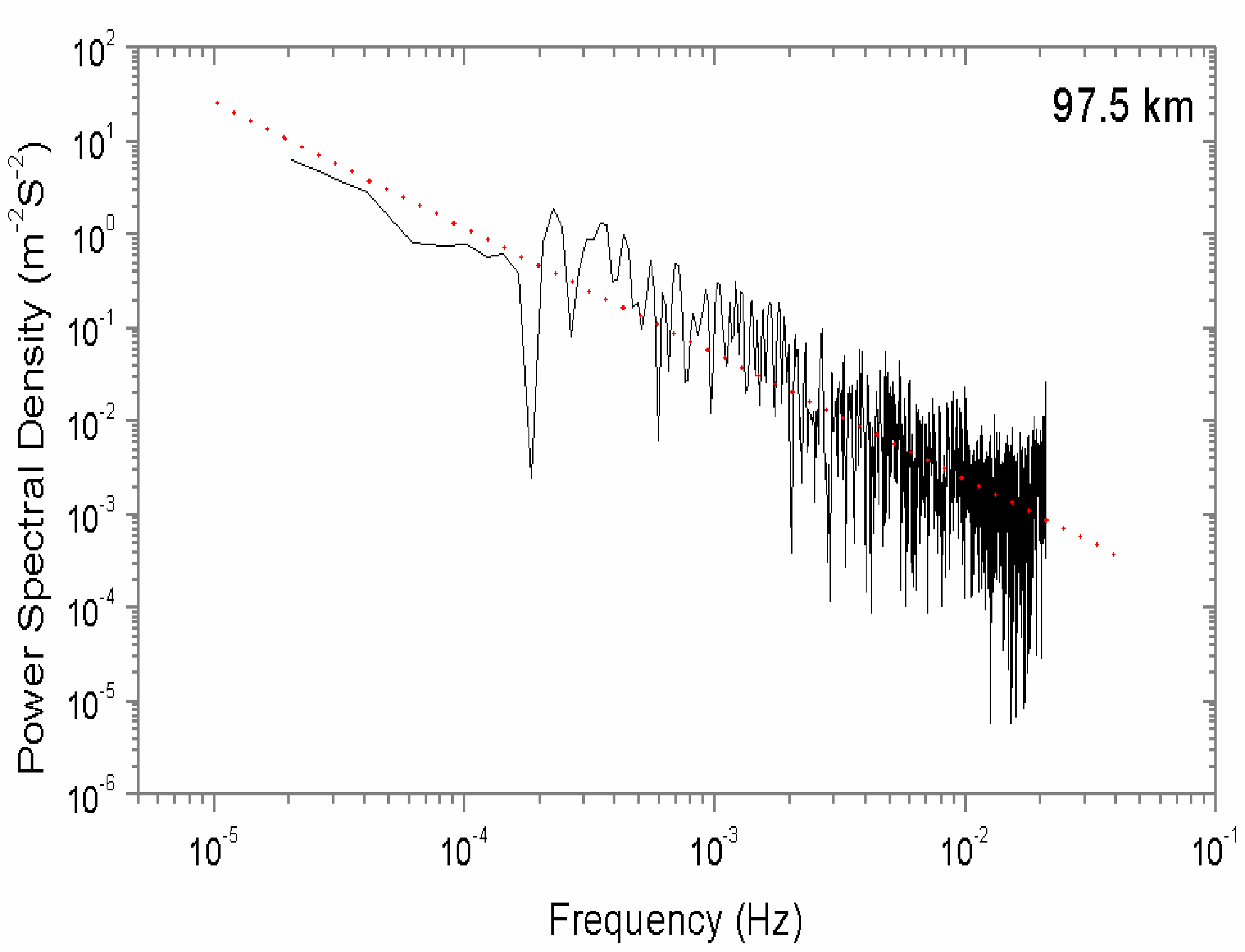


Short Period waves found with Zonal and Meridional Direction





PSD Vs Frequency at 92.5 km



Results

- The Spectral power density slope with the frequency is equal to -1.61965 which is nearly equal to -5/3.
- The short period gravity waves are found in the range of 30-50 minutes.
- The 15 min mean wind show the wind is mostly southward and turn to eastward as the night weans below 97 km.
- It rotates from North to East between 97 and 107 km.

VHF Radar Observations on Meteor Induced Turbulent Plasma Irregularity Layers

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2 National MST radar Facility, P.Box. No.123, Tirupati, 517 502, AP, India.

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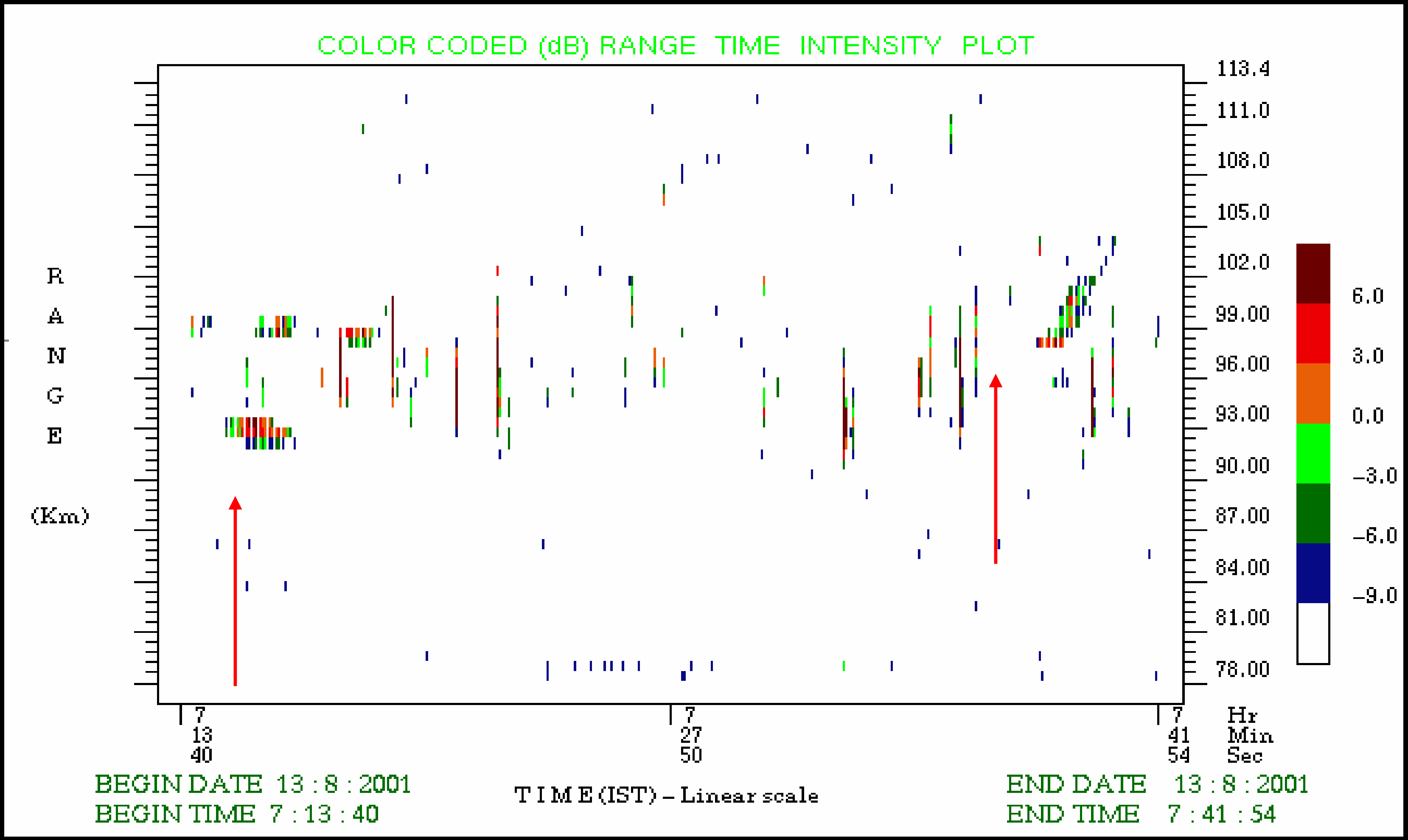
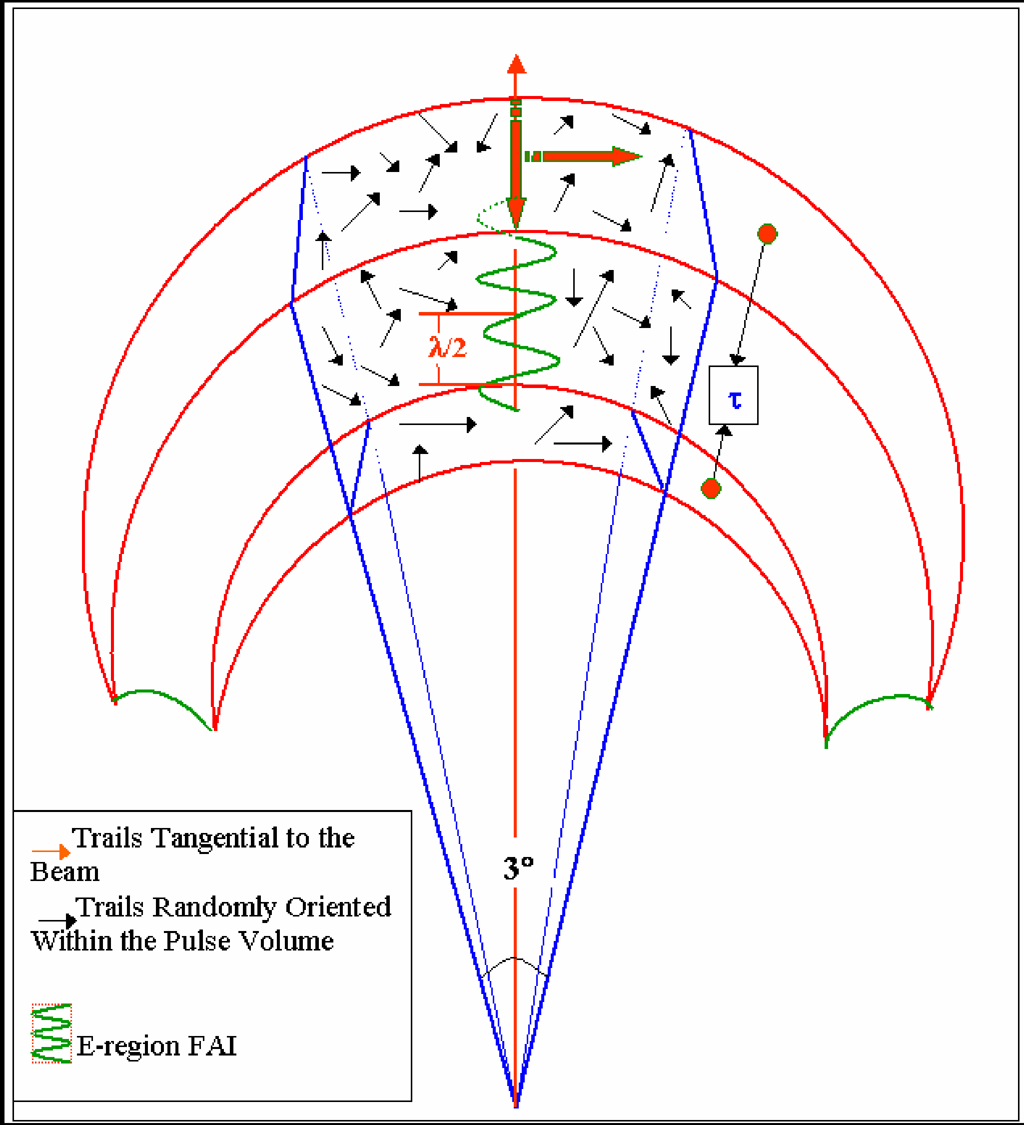
Range-Time-Intensity Plot

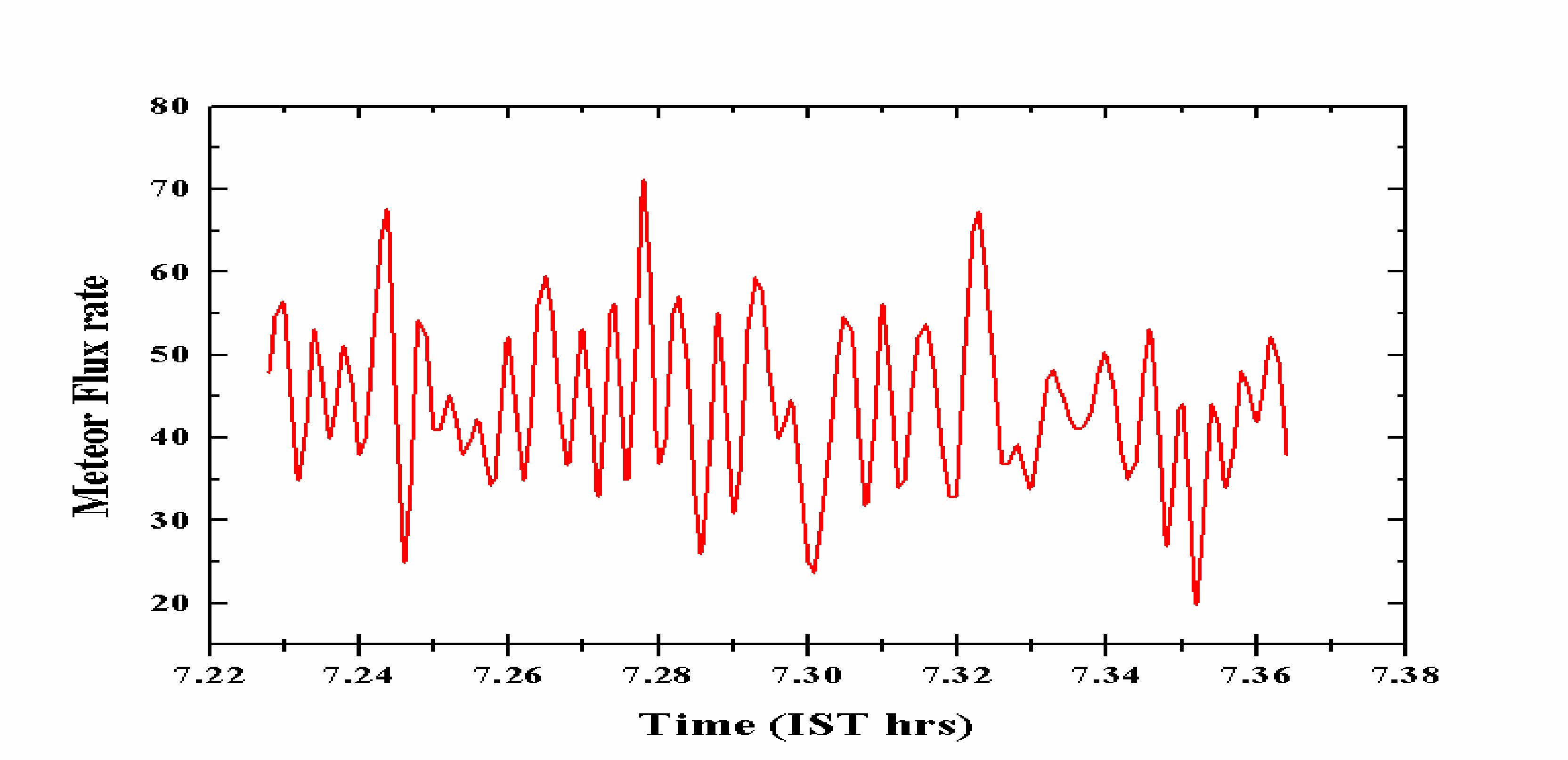


Schematic Sampling Pulse Volume with Different Tracers

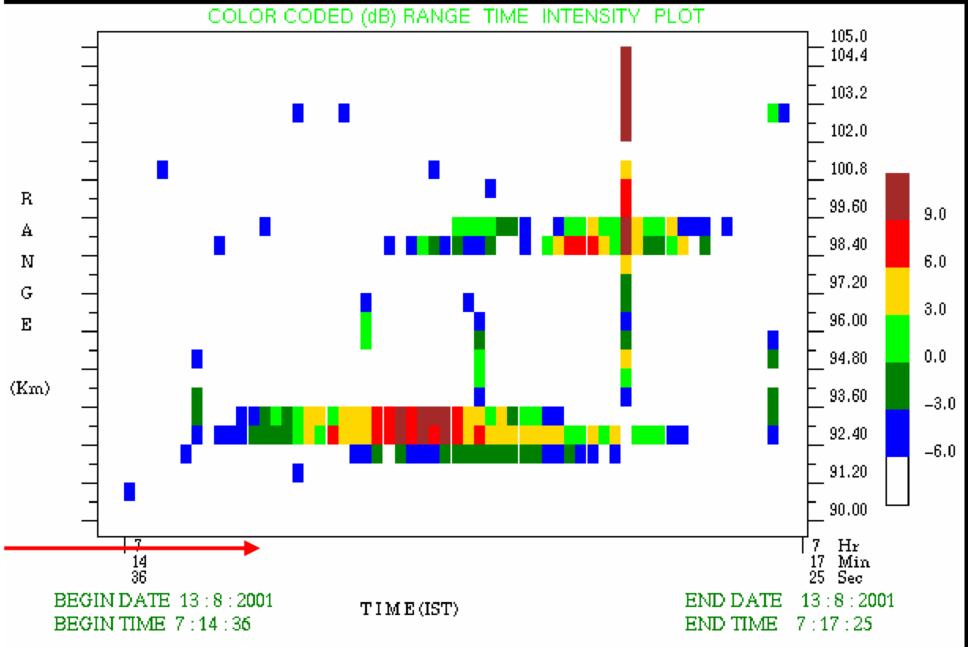


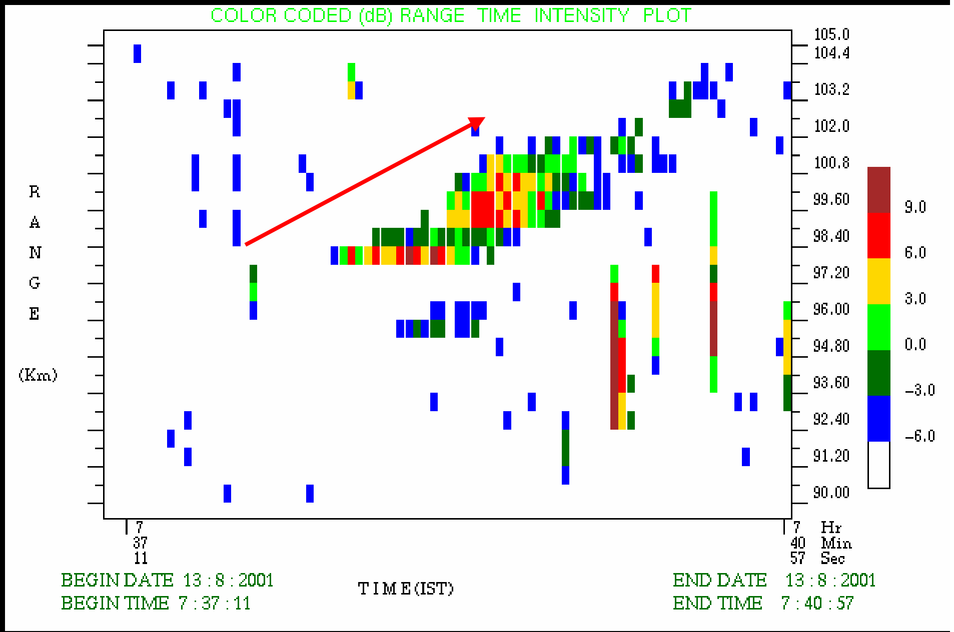
Not to scale

Meteor flux Rate

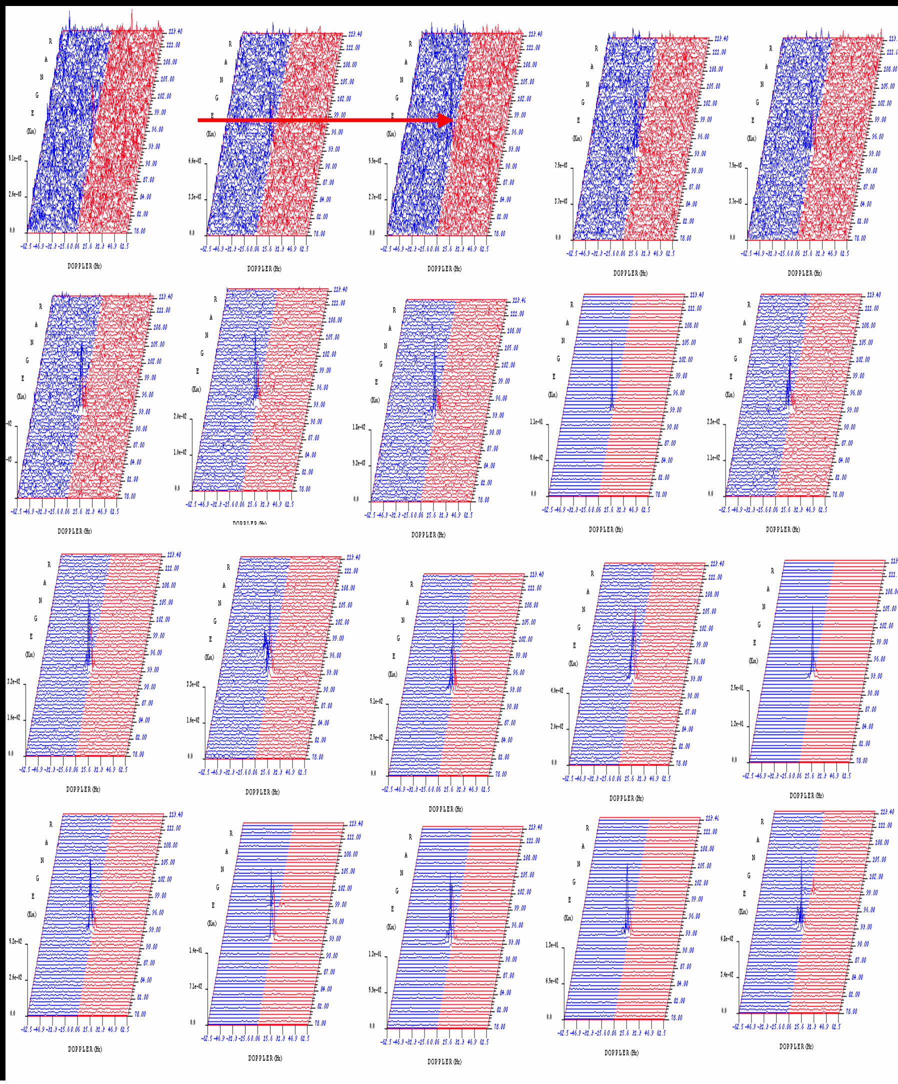


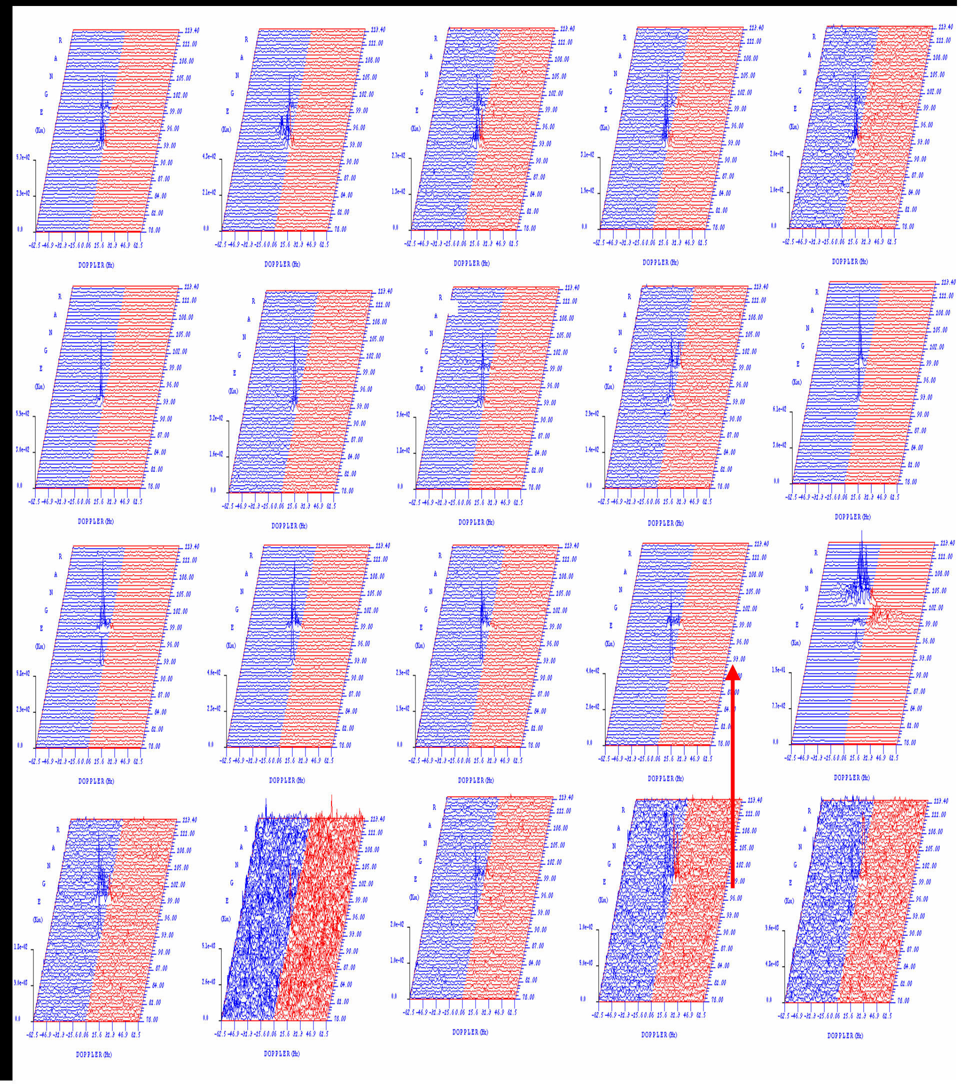
Meteor Trail Layer



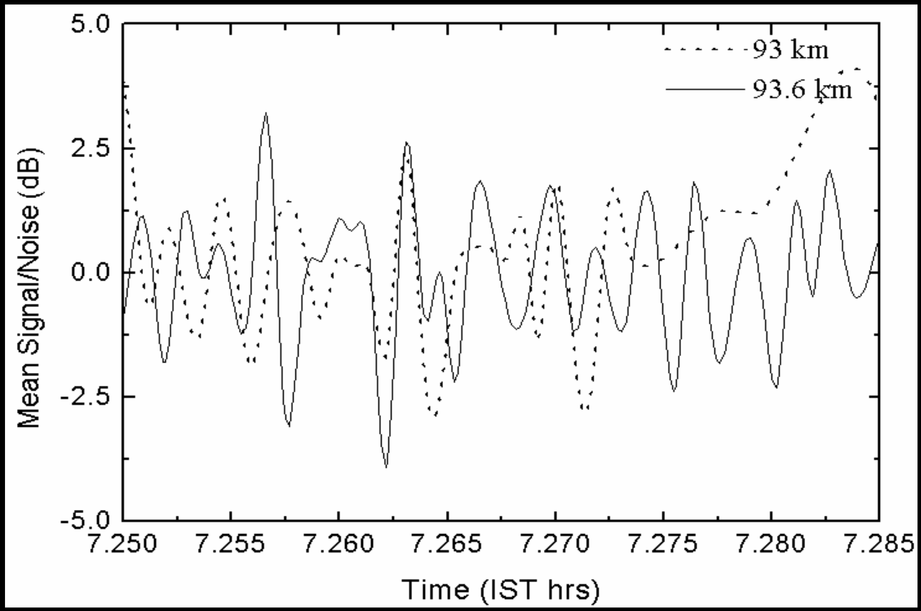


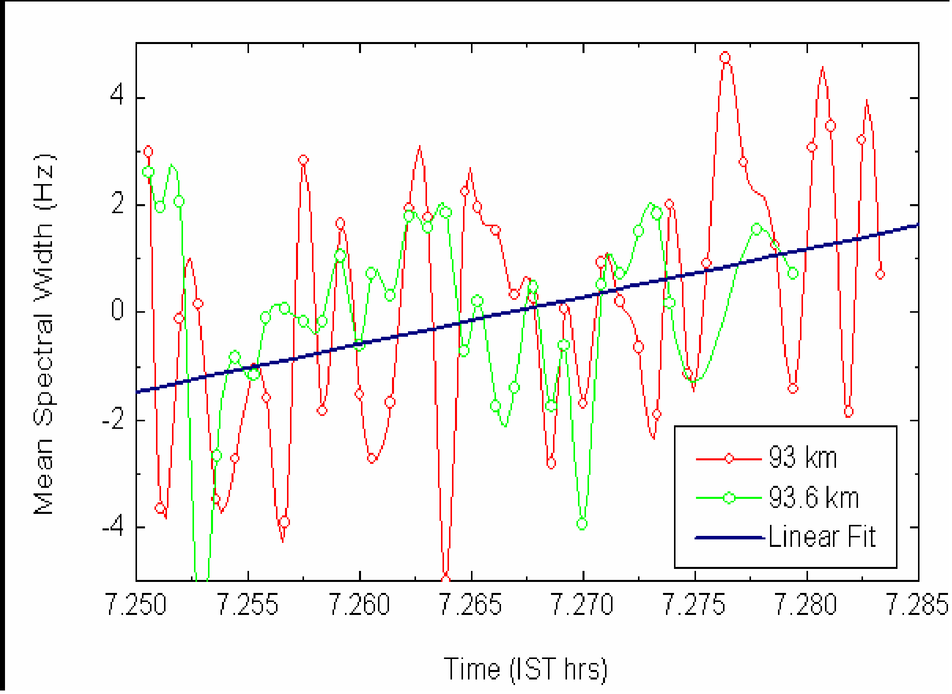
Meteor trail echo-during 07:15:02–07:16:55 on 13AUG 2001



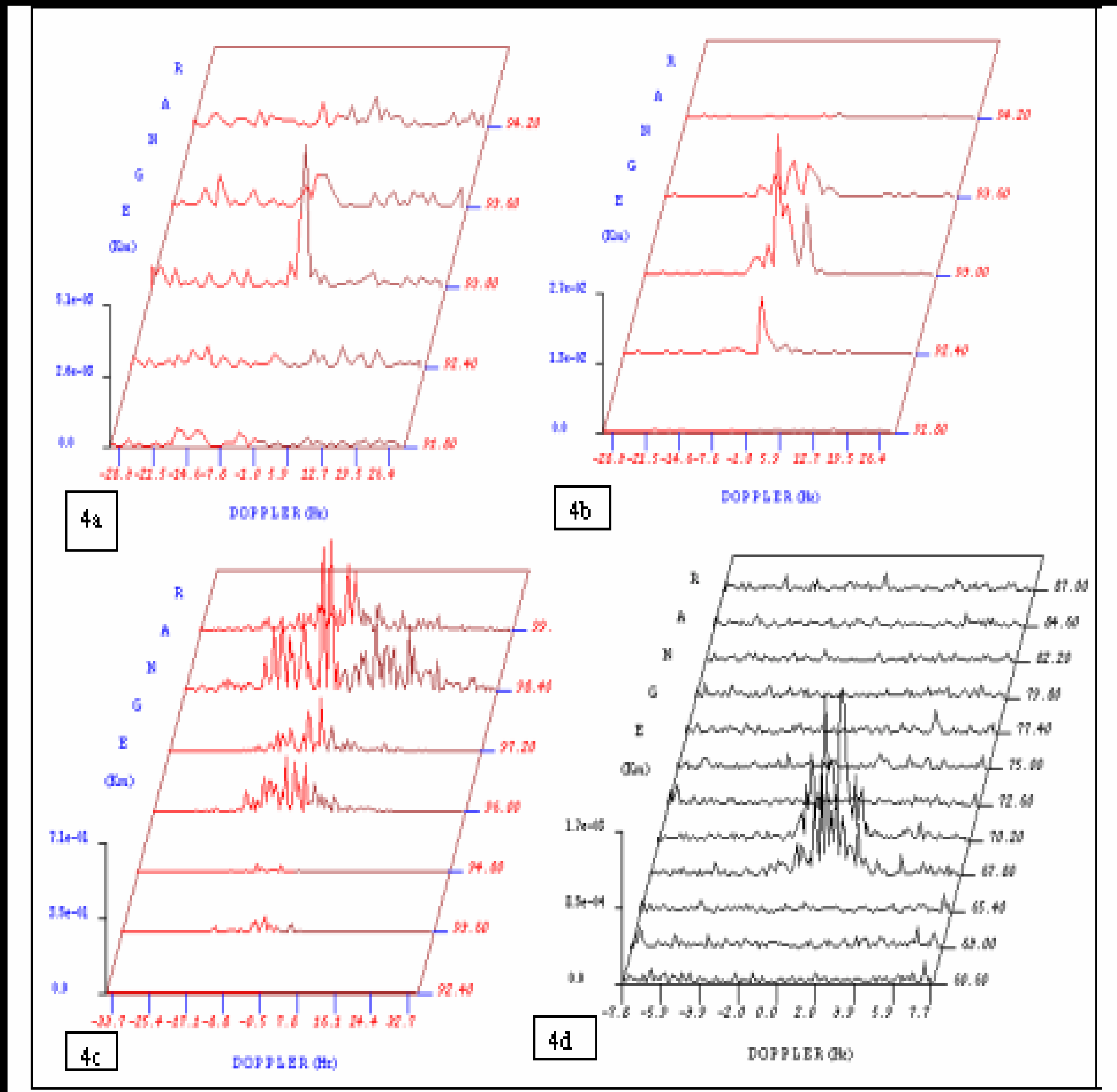


Mean S / N ratio and Spectral width





Spectral Signatures



Results

The turbulent plasma irregularity within meteor trail seem to develop when,

- large electric field is generated perpendicular to both the geomagnetic field and the trail length
- irregular density of plasma evolving as waves across the trail only when it is in tangential plane to the B field.
- saturated plasma waves break into the turbulent plasma within the trail. The time evolution of the turbulent plasma irregularity layer in the present observation has explained the trail dynamics controlled by $E \times B$ drift mechanism in the absence of neutral wind shears.
- The drift of trail is largely controlled by $E \times B$ drift mechanism where E is setup by the meteor trail due to the density gradients at its edges of the trails.