Transient echo Experiments observed using Indian MST radar

Associates

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### **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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# 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

Signal-to-Noise Ratio Vs Spectral Width on Meteor Shower day (top most panel) and Non-Meteor Shower days (bottom panels)

![](_page_6_Figure_2.jpeg)

#### Spectral Width Vs Mean Doppler frequency Characteristics Corresponding to the Event

![](_page_6_Figure_4.jpeg)

### 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

![](_page_8_Figure_1.jpeg)

![](_page_9_Figure_0.jpeg)

Simulated Gaussian Electron density Fluctuations With Height and Time

#### **Electron Density CIRA-86**

![](_page_9_Figure_3.jpeg)

#### Simulated Vertical Gaussian Distribution of Penetration of Meteor trails

![](_page_10_Figure_1.jpeg)

![](_page_11_Figure_0.jpeg)

Simulated Gaussian Electron density Fluctuations With Height and Time

#### **Electron Density CIRA-86**

![](_page_11_Figure_3.jpeg)

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

![](_page_12_Figure_1.jpeg)

### 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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#### MST radar Raw data obtained during Lightning

#### \*\*\*MST RADAR DATA HEADER\*\*\*

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![](_page_16_Figure_0.jpeg)

![](_page_17_Figure_0.jpeg)

#### Lightning Echo Amplitude Characteristics

![](_page_18_Figure_1.jpeg)

#### Phase and Amplitude records corresponding to the Lightning

![](_page_19_Figure_1.jpeg)

#### Phase and Amplitude records corresponding to the Lightning

![](_page_20_Figure_1.jpeg)

# Phase and Amplitude records corresponding to the Lightning

![](_page_21_Figure_1.jpeg)

![](_page_22_Figure_0.jpeg)

# 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

![](_page_25_Figure_2.jpeg)

#### Local Time Vs Meridional Wind

![](_page_26_Figure_1.jpeg)

### **Height Vs Zonal Wind**

![](_page_27_Figure_1.jpeg)

## **Height Vs Meridional Wind**

![](_page_28_Figure_1.jpeg)

#### Zonal Wind during Sep and Dec 2001 representing Equinox and Winter

![](_page_29_Figure_1.jpeg)

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

![](_page_29_Figure_3.jpeg)

### Wind Variance Zonal and Meridional Direction

![](_page_30_Figure_1.jpeg)

### Zonal wind Vs Meridional Wind Variance

![](_page_31_Figure_1.jpeg)

# Gravity wave periods found with Zonal wind

#### **Tidal Wave Amplitudes in Zonal Wind component**

![](_page_32_Picture_2.jpeg)

![](_page_32_Picture_3.jpeg)

![](_page_32_Picture_4.jpeg)

#### **Tidal Wave Phase Obtained with Zonal Component**

![](_page_32_Picture_6.jpeg)

## Gravity wave periods found with Meridional Wind

#### **Tidal Wave Amplitudes in Meridional Component**

![](_page_33_Picture_2.jpeg)

![](_page_33_Picture_3.jpeg)

#### **Tidal Wave Phase Observed with Meridional Component**

![](_page_33_Picture_5.jpeg)

### **Relative Occurrence of Gravity** wave periods

![](_page_34_Figure_1.jpeg)

![](_page_34_Figure_2.jpeg)

![](_page_34_Picture_3.jpeg)

![](_page_34_Figure_4.jpeg)

### 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  $\pm 20 \text{ ms}^{-1}$  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**

![](_page_37_Figure_1.jpeg)

#### Meridional

![](_page_37_Figure_3.jpeg)

### **Mean Wind Direction**

![](_page_38_Figure_1.jpeg)

### Short Period waves found with Zonal and Meridional Direction

![](_page_39_Figure_1.jpeg)

### **PSD Vs Frequency at 92.5 km**

![](_page_40_Figure_1.jpeg)

### 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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### **Range-Time-Intensity Plot**

![](_page_43_Figure_1.jpeg)

### Schematic Sampling Pulse Volume with Different Tracers

![](_page_44_Figure_1.jpeg)

Not to scale

# **Meteor flux Rate**

![](_page_45_Figure_1.jpeg)

### **Meteor Trail Layer**

![](_page_46_Figure_1.jpeg)

![](_page_46_Figure_2.jpeg)

![](_page_46_Figure_3.jpeg)

![](_page_46_Figure_4.jpeg)

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

1077138-06

DOPPLER (H)

![](_page_47_Figure_1.jpeg)

![](_page_47_Figure_2.jpeg)

![](_page_47_Figure_3.jpeg)

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TOPPLER (%)

2140-81-8008 S1 81 81 8

DOPPLIE (b)

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![](_page_47_Figure_4.jpeg)

![](_page_47_Figure_5.jpeg)

![](_page_47_Figure_6.jpeg)

![](_page_47_Figure_7.jpeg)

# Mean S/N ratio and Spectral width

![](_page_48_Figure_1.jpeg)

![](_page_48_Figure_2.jpeg)

### **Spectral Signatures**

![](_page_49_Figure_1.jpeg)

### **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 ExB drift mechanism in the absence of neutral wind shears.
- The drift of trail is largely controlled by E×B drift mechanism where E is setup by the meteor trail due to the density gradients at its edges of the trails.