Studies of equatorial spread-F using LISN VIPIR

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Introduction:

LISN, the Low Latitude Ionospheric Sensor Network, is a distributed observatory. LISN represents a closely coordinated geophysical instrument set, comprised of GPS receivers providing TEC values and scintillation measurements, magnetometers providing daytime ionospheric electric fields and Vertical Incidence Pulsed Ionospheric Radar (VIPIR) providing ionograms.

The LISN Observatory was designed to do continuous measurements using GPS receivers, VIPIR ionosondes and flux gate magnetometers; provide a nowcast of TEC, S4 index, and other derived parameters of the low-latitude ionosphere.

The LISN-GPS network of 70 GPS receivers (planned, about 45+ connected now) and 5 VIPIR ionosondes planned in the same field line, will make it possible to address science questions regarding: the effect of E and Es layers on inhibiting ESF, the role of Gravity Waves on seeding plasma bubbles. It will also provide clues to understand the causes of day-to-day variability of the low-latitude ionosphere.

The first VIPIR ionosonde has been installed and working temporarily in Jicamarca since October 2008. The VIPIR is able to operate in different modes; we have used high temporal and spatial resolution modes to measure the E and F regions. We carried out a campaign during March 2009 that aimed to measure the effect of gravity waves on the ionospheric densities and to observe the means of gravity waves as a seeding mechanism for spread F. This poster describes the preliminary results on the characteristics of ionospheric density structures, velocities during spread-F conditions from the VIPIR data.

VIPIR Ionosonde:
(Bullett, Livingston, and Grubb)

VIPIR is designed for extreme performance and flexibility, it can record ionograms every 6 secs; it configures

8 Receiving Antennas – dipoles (4 N/S and 4 E/W) and

4 Transmitting Antenna towers (Log periodic)

It can be configured to work in many different modes like E-region mode, Fast sweep mode, Dg21 etc.

During the March 2009 campaign it was operated in two modes, ionogram and a special mode which samples 8 frequencies at 128 repeats enabling to study the spectral characteristics.

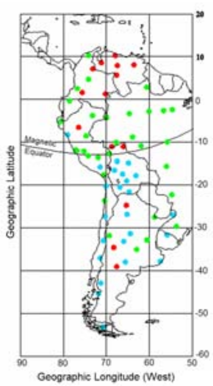


Fig 1. LISN network. On the left showing the locations of GPS receivers with status; and the right indicating planned VIPIR installations.

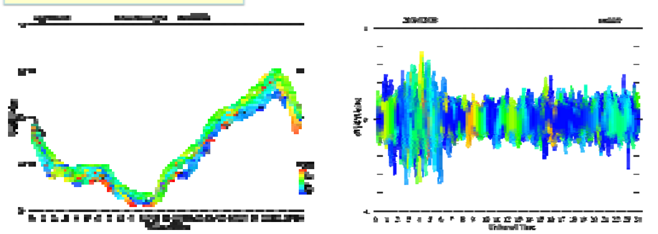
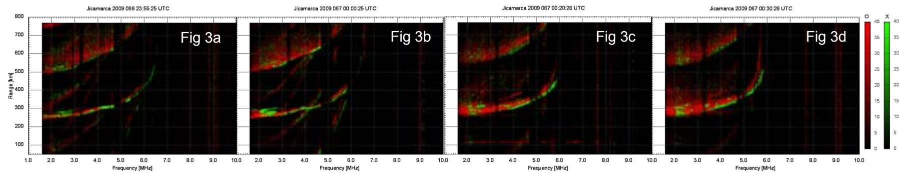


Fig 2.GPS-TEC from Sanisidr, shows the gravity wave signatures, which are clear from Fig 2(b) dTEC plot.



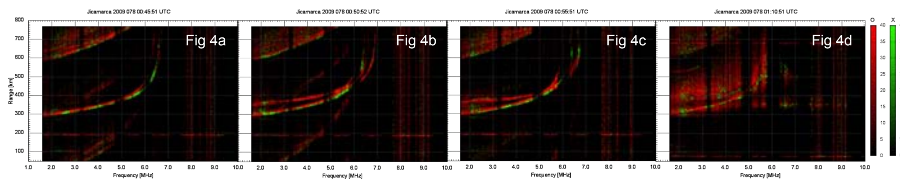


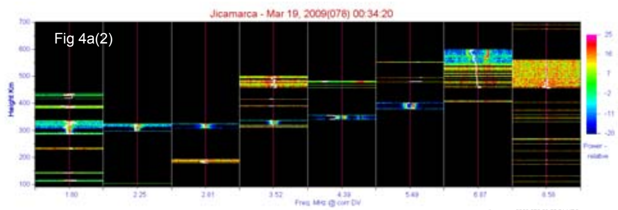
Fig 3(a,b,c,d). Ionograms showing the gravity wave superposed on trace before the onset of spread-F on early hours of May 8, 2009 (UT).

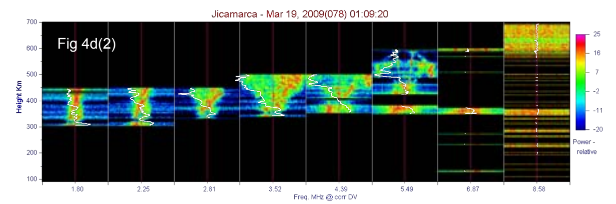
Fig 4(a,b,c,d). Ionograms showing two traces, the second one possibly from the edge of a bubble.

Fig 4a(2). Doppler spectrum at each of the freqencies (-4 to 4 Hz) with mean doppler velocities (white line) +/- 50 m/s which correspond to the ionograms Fig 4a.

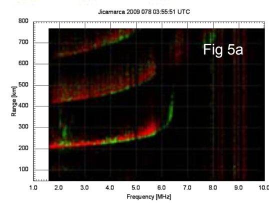
Similarly, Fig 4d(2) is the doppler spectra during the spread-F corresponding to ionogram Fig 4d.

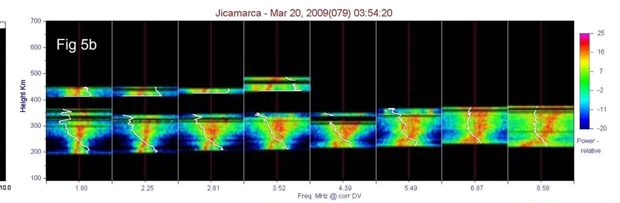
Fig 5b shows the doppler spectra pattern during cease of spread-F corresponding to ionogram Fig 5a.





The VIPIR is operated in a mode which transmits 8 frequencies with 128 repeats; this makes each frequency observed at sampling interval of 0.064 seconds. These series is used to calculate the doppler spectra and mean velocities as shown in figures 4a(2), d(2) and 5b. The scale of the spectrum is from -4 to 4 Hz for each frequency and the mean velocity scale varies from -50 m/s to 50 m/s.





Summary:

The TEC data from Ancon, Sanisidro and Jicamarca were used to detect the presence of gravity waves. The wave patterns are seen in figures 2 a,b and also the from the correlation coefficient and time delay of the pattern between the stations show the characteristic of gravity wave propagation, which coincides with the onset of spread-F in the ionograms. Also, in fig. 3a the gravity wave structure is seen in the ionogram. More study of the doppler spectra could explain the irregular scale sizes/ patterns during spread-F.

With the complete installation of VIPIRs along the field line as planned, we should be able to assess and address the effect of E and Es layers on inhibiting ESF, the role of Gravity Waves on seeding spread-F and plasma bubbles. It will also provide clues to understand the causes of day-to-day variability of the low-latitude ionosphere.

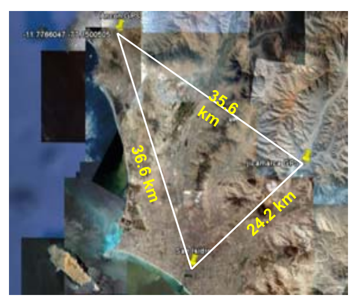


Fig 6. stations used in March 2009 Gravity Wave Campaign

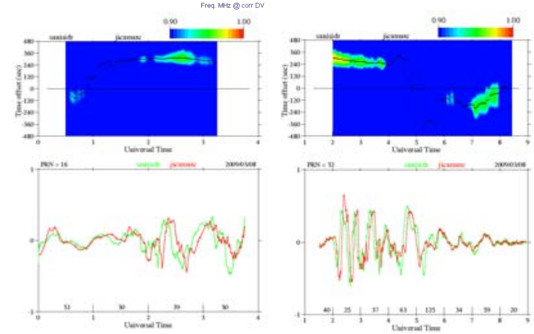


Fig 7 a,b. showing PRNs 16, 32 where possible gravity wave structure is present, along with correlation function delays between Sanisidr & Jicamarca