The Jicamarca Radio Observatory and its cluster of instruments

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Brief introduction

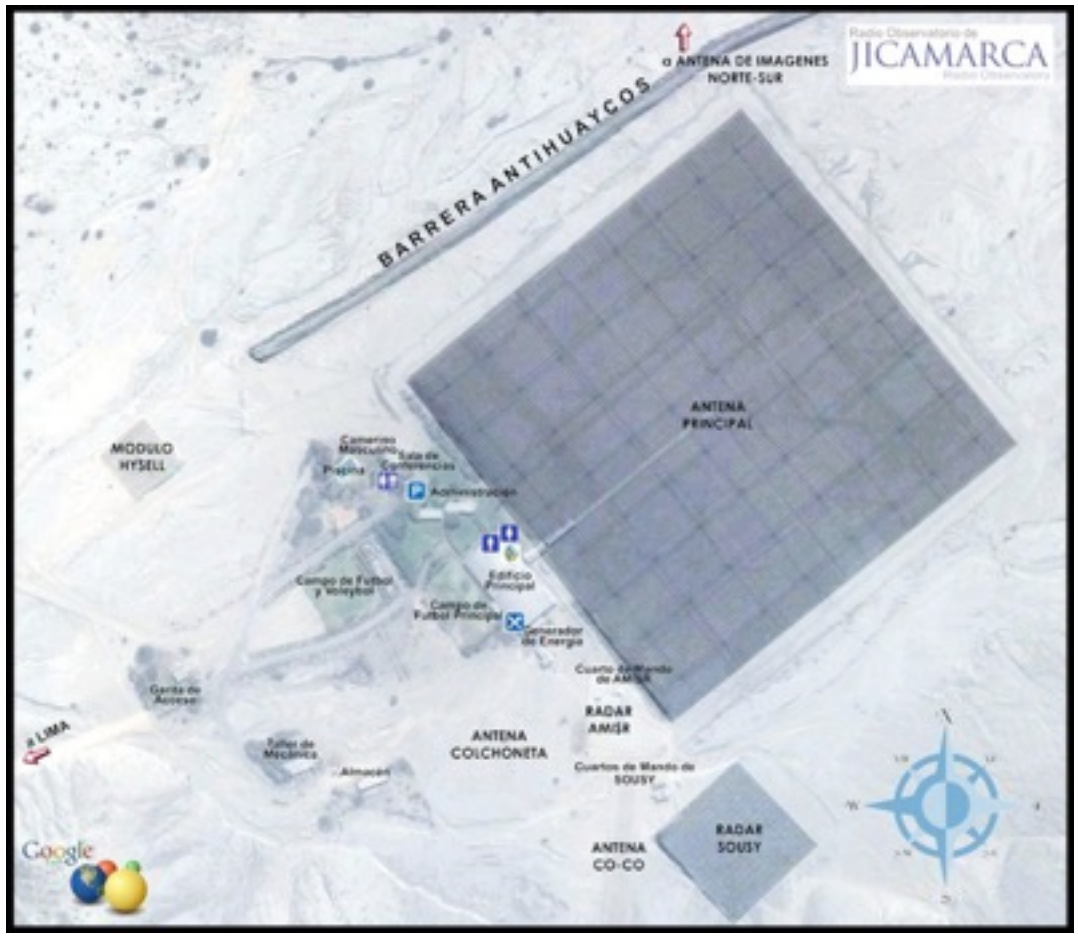
Jicamarca Radio Observatory

Our main instrument is one of the largest incoherent scatter radars in the World.

- It is a research center dedicated to study the ionosphere and upper atmosphere.
- Located at ~20 km east of Lima, Peru. (11.95°S, 76.87°W).
- It is part of a chain of ionospheric observatories in the American continent.
- Operates a variety of instruments: IS and CS radars, ionosondes, magnetometers, GPS receivers, Fabry Perot interferometers, all-sky cameras, etc.

Characteristics of the Jicamarca Radar

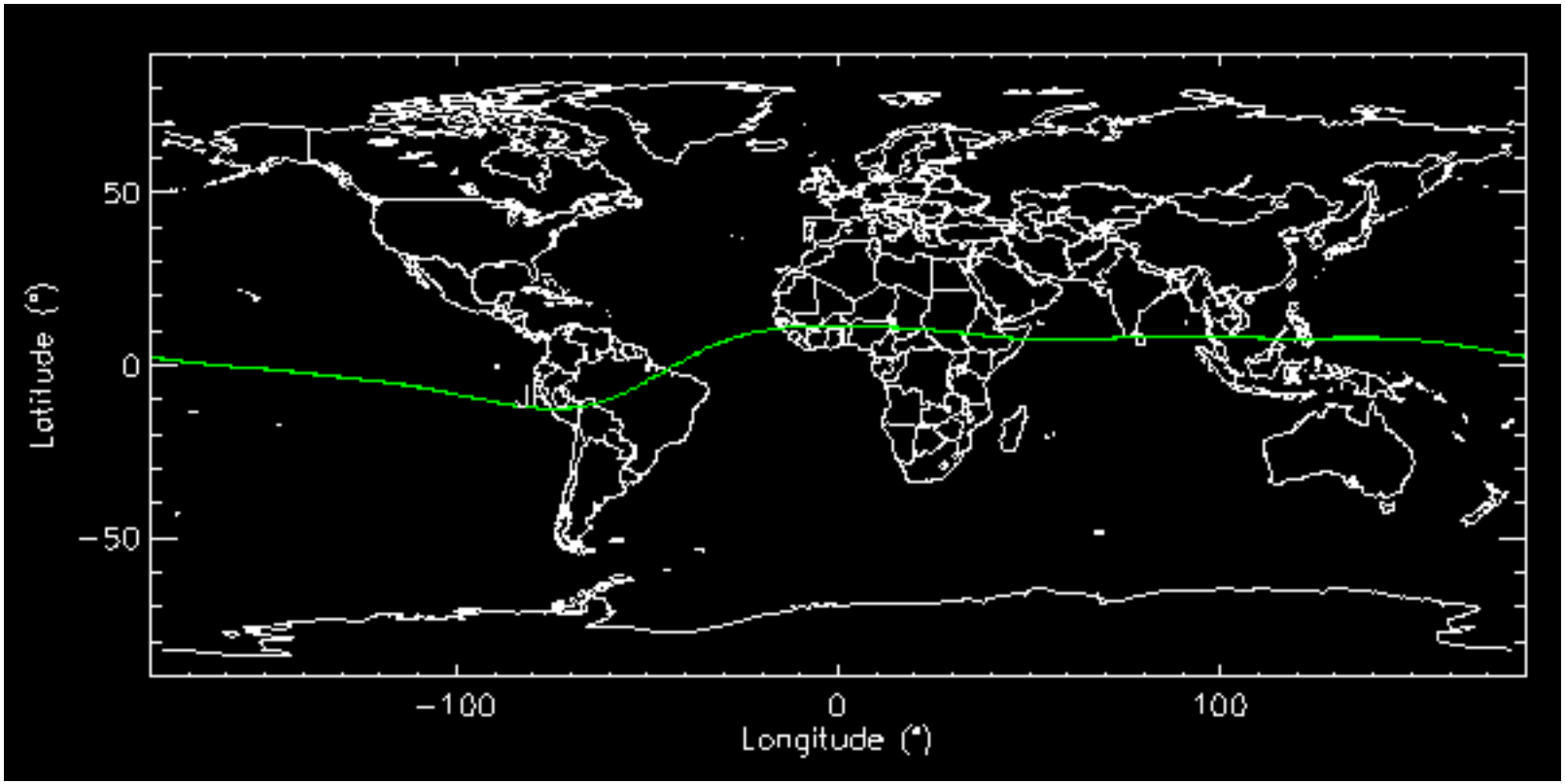
- Operating frequency: 50 MHz
- Antenna: array of 18,432 half-wave dipoles (area of 300x300 m^2).
- The antenna is composed of 8x8 cross-polarized modules that can be combined in multiple ways.
- Pointing directions: within 3 degrees from on-axis.
- Electronic ABS for North and South quarters, phasing in the East and West quarters is performed manually.
- Transmitters: 3 x 1.5 MW peak-power with 5% duty cycle.
  Fourth TX under repair.
- We also have a set of low-power TXs (10 - 20 kW).



Peculiarities of Jicamarca

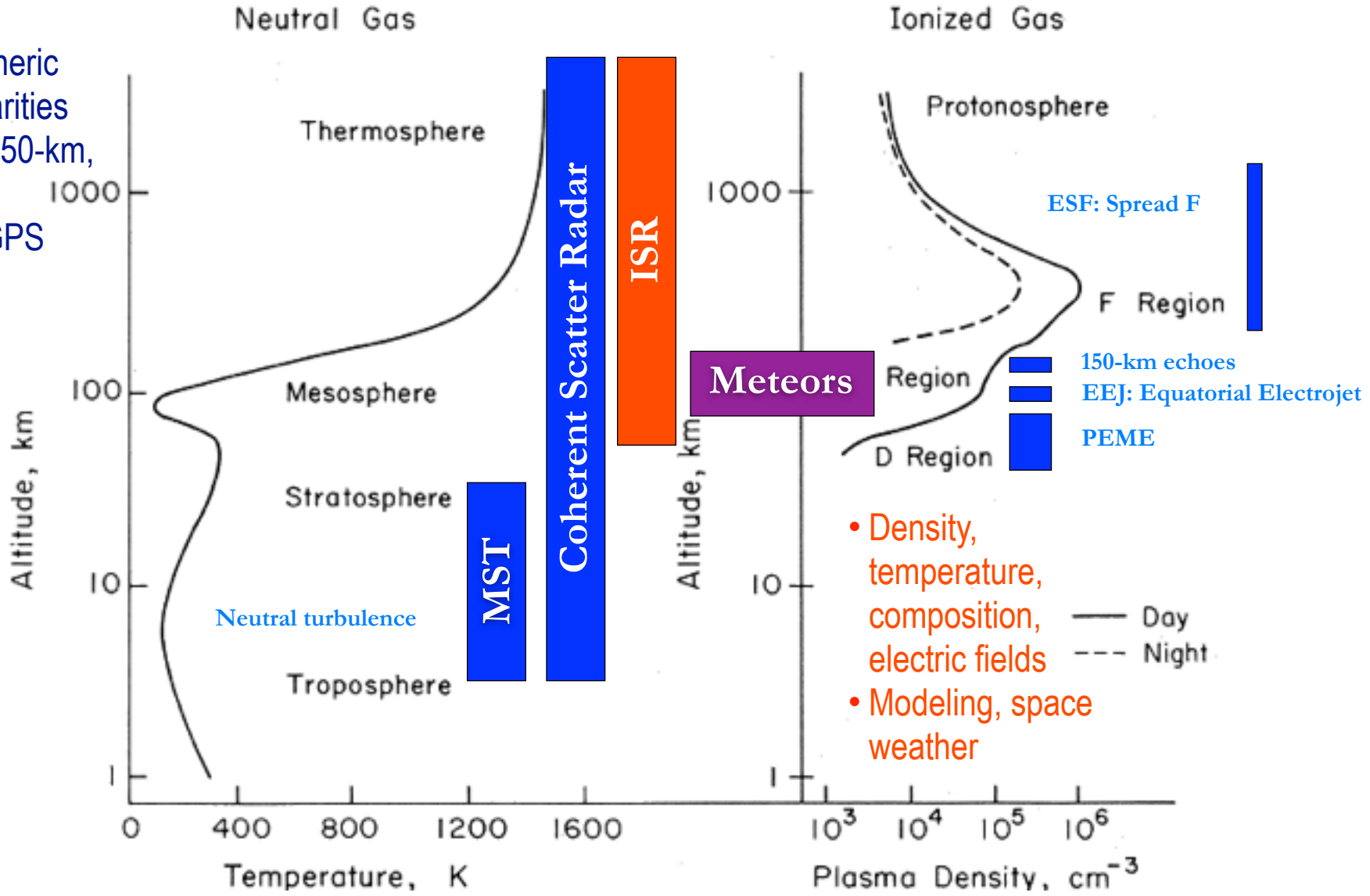
Why at Jicamarca?

- It is under de magnetic Equator (use of large horizontal antenna).
- It was built between 1960-1962. Dr. Ken Bowles, the founder of Jicamarca, worked in Peru (with IGP people) during the IGY 1958.
- It is free of electromagnetic interference (surrounded by mountains).



What do we study at Jicamarca?

- Ionospheric Irregularities (EEJ, 150-km, ESF).
- SAR, GPS

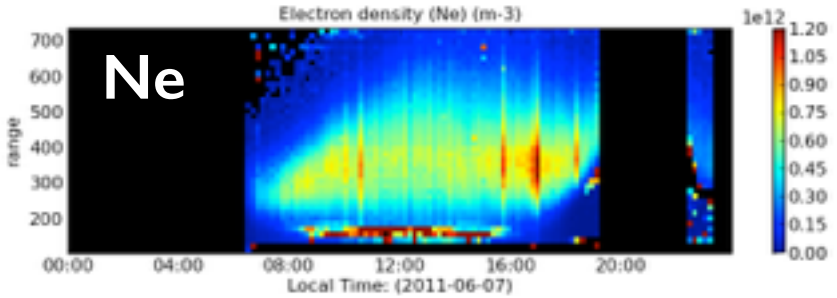


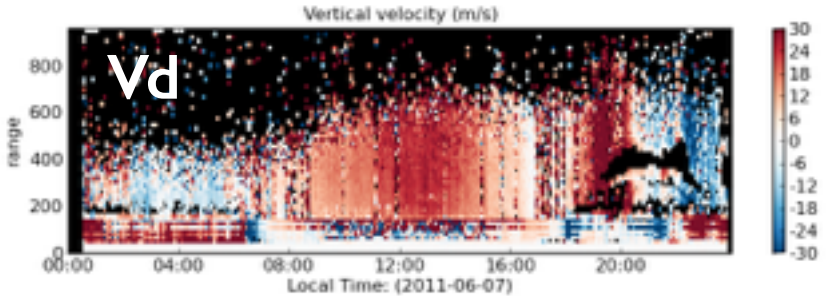
- Neutral atmosphere dynamics (winds, turbulence, vertical velocities)
- Meteorology, aviation.

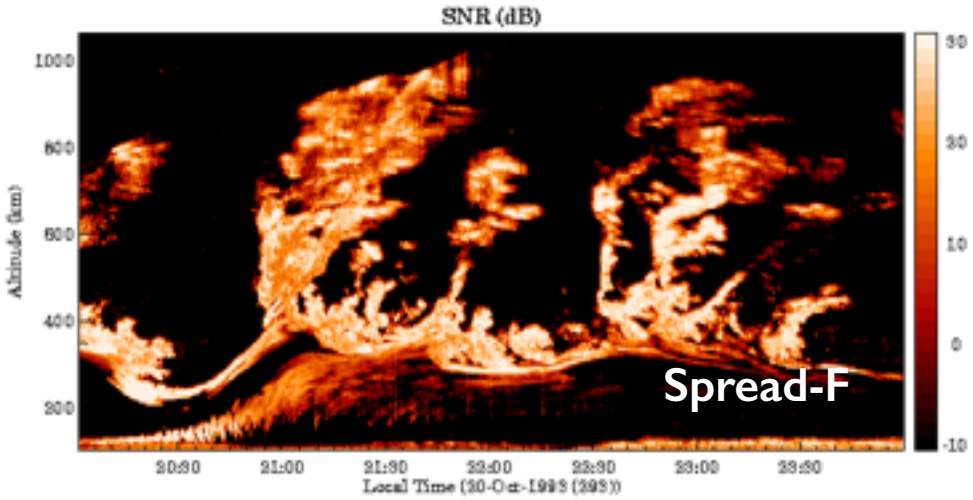
- Density, temperature, composition, electric fields
- Modeling, space weather

More about what we study at Jicamarca

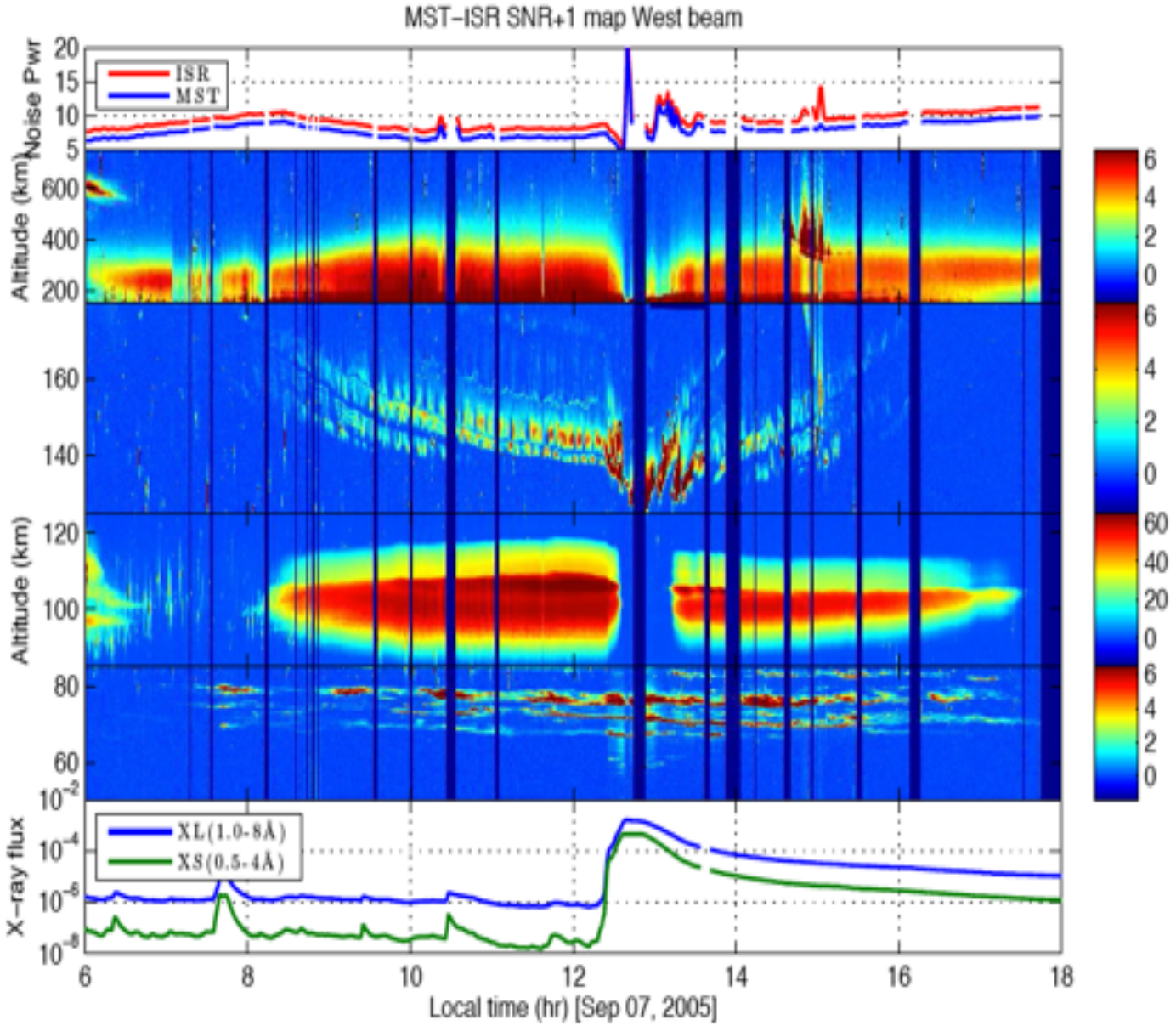
- Dynamics of the equatorial ionosphere
  - Physical parameters (Ne, Te, Ti, Vd, Zd, %O^+, %H^+, %He^+).
  - Spectral characteristics of plasma irregularities (Electrojet, Spread-F, 150km echoes).
- Dynamics of the neutral atmosphere - MST (Mesosphere, Stratosphere, and Troposphere).
- Meteor detection and characterization.
- Radio astronomy, others.





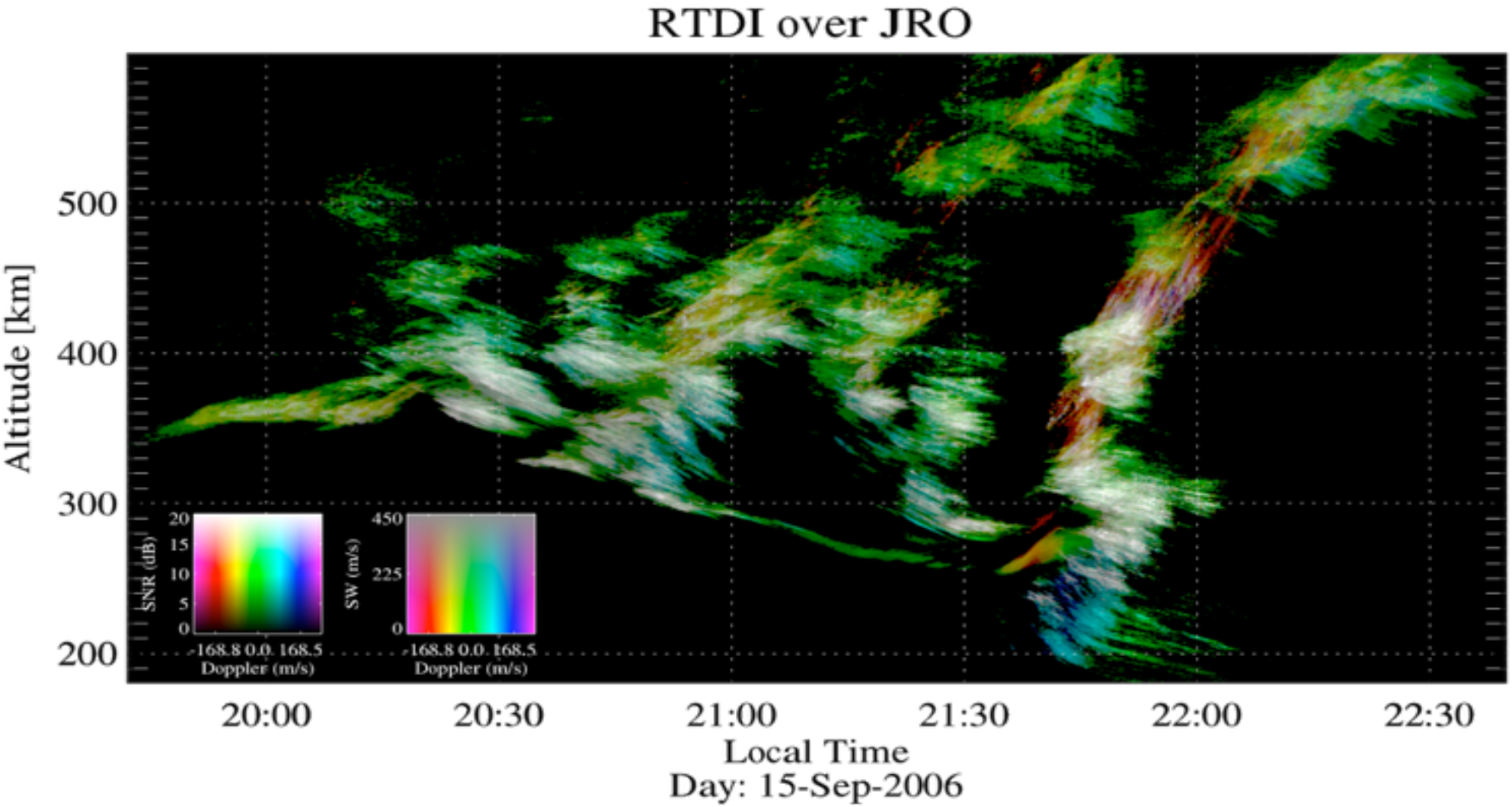


A "typical" day above Jicamarca



- ExB drifts from 150-km first moment.
- Plasma physics from EEJ spectra.
- Plasma physics and lower thermosphere winds from non-specular meteor trails.
- Mesospheric winds from mesospheric echoes.

A "typical" night above Jicamarca



Effect of the F-region dynamics near sunset on the generation of Spread-F plumes.

The instruments around Jicamarca

Network of instruments in Peru

- LISN (C. Valladares, BC) network of GPS receivers, magnetometers and ionosondes.
- Magnetometer chain (O. Veliz, IGP)
- Ionosondes
  - Digisonde (B. Reinish, U. Mass. Lowell)
  - VIPIR (E. Kudeki, J. Makela, Illinois)
- Beacon RXs (P. Bernhardt, NRL, Tsunoda, SRI)
- GNSS RXs (J. Morton, MU)
- CIRI Huancayo (J. Urbina, PSU)
- AMISR14 (J. Arratia, UMET) (under repair)
- FPI chain + SOFDI (J. Meriwether, Clemson, A. Gerrard, NJIT)
- Airglow cameras (C. Martinis, BU, G. Swenson, Illinois)
- Multi-static HF Radar (D. Hysell, Cornell)
- TIDDBIT is back soon (G. Crowley, ASTRA)

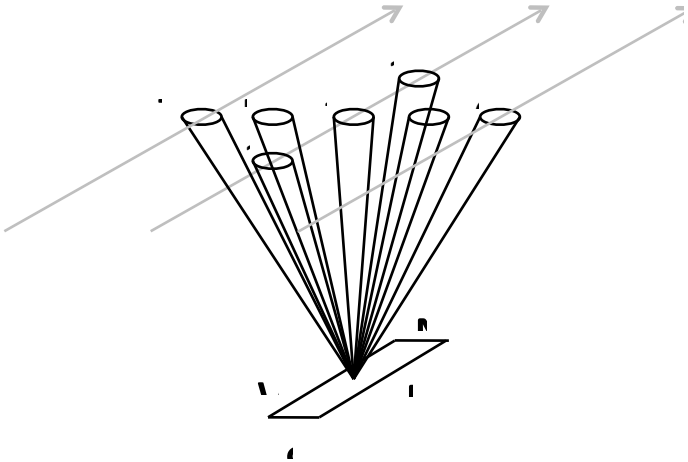
LISN - Center of operations at Jicamarca

- LISN - Low-Latitude Ionospheric Sensor Network
- It is a distributed network of instruments deployed in South America for monitoring the ionosphere.
- Instruments:
  - VIPIR ionosondes
  - GPS receivers
  - Magnetometers
- Measurements:
  - TEC,
- Data is available at http://lisn.igp.gob.pe

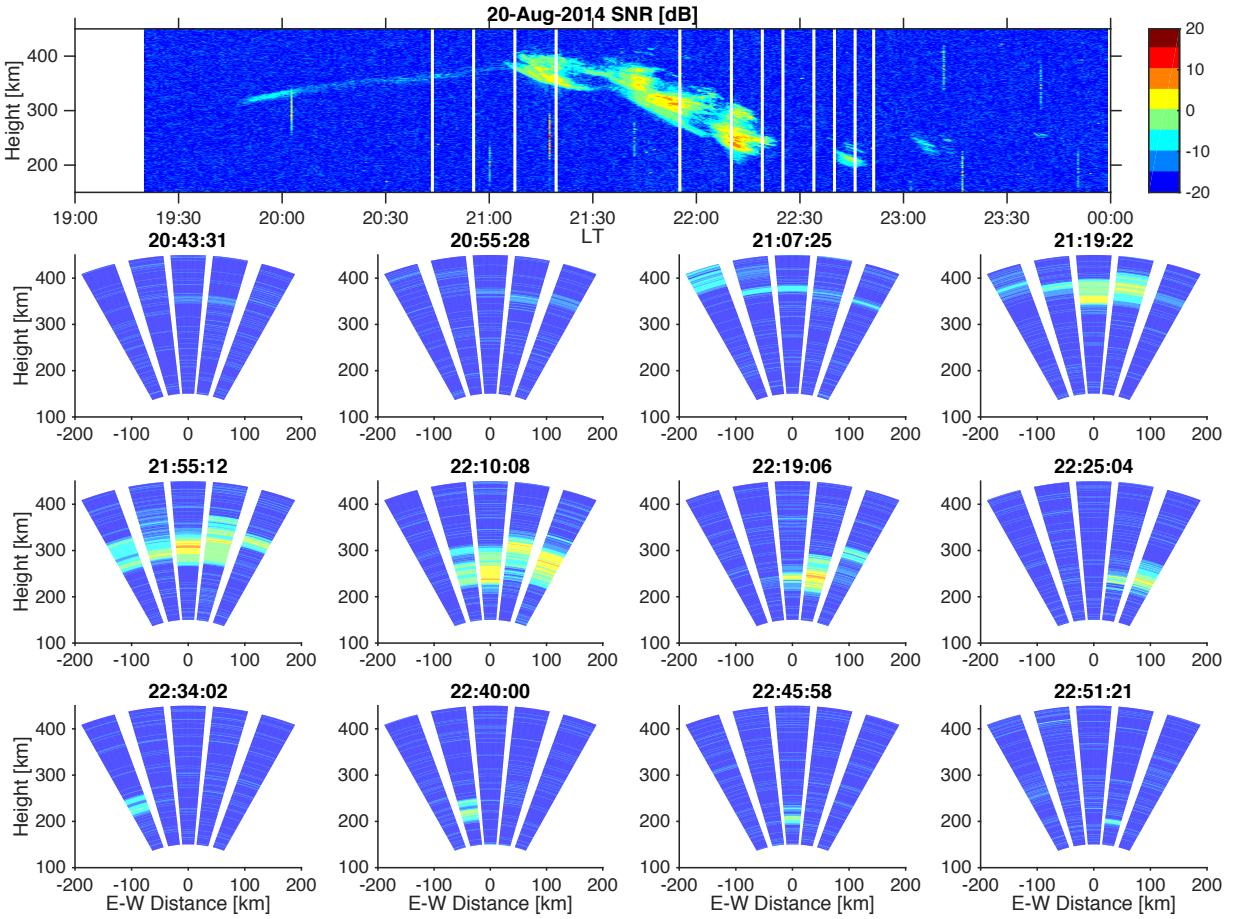
AMISR-14 at Jicamarca

- 14 AMISR panels were deployed at Jicamarca in August 2014.
- Each panel has 32 cross polarized dipoles and can deliver a peak power of 16kW.
- The frequency of operation will be between 430 - 450 MHz.
- Modulation: Phase coded, 1 usec minimum baud length.
- This new system is suitable for plasma irregularity observations at the magnetic equator (electrojet and spread-F) and also for meteors and debris detection.

First Spread-F observations with AMISR-14

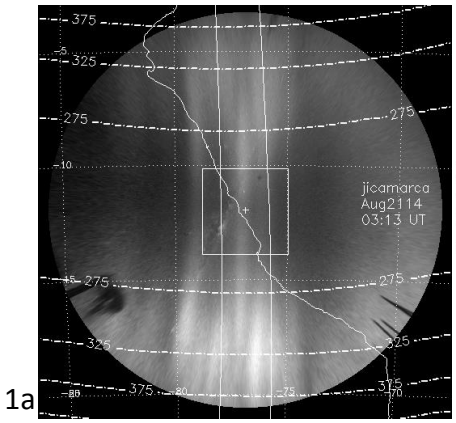


Equatorial Spread-F observations conducted with the AMISR-14 system making use of its electronic beam steering capability in August 2014.



This kind of measurements allows the study of ESF dynamics in the equatorial EW plane.

Comparison of all-sky imager and radar observations of ESF irregularities



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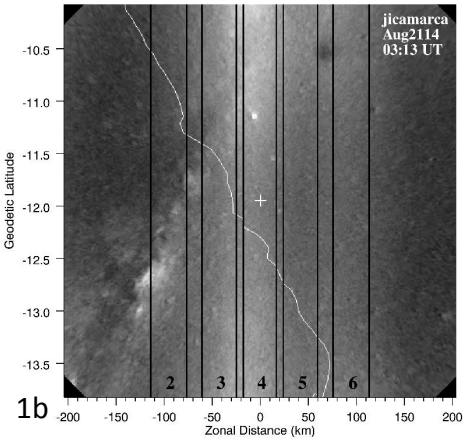

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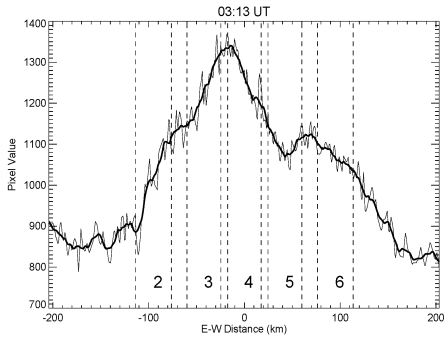

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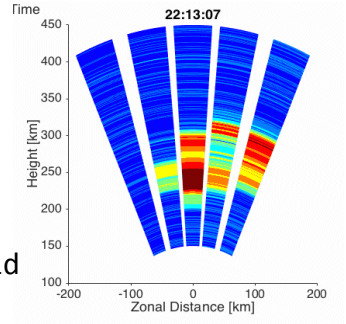

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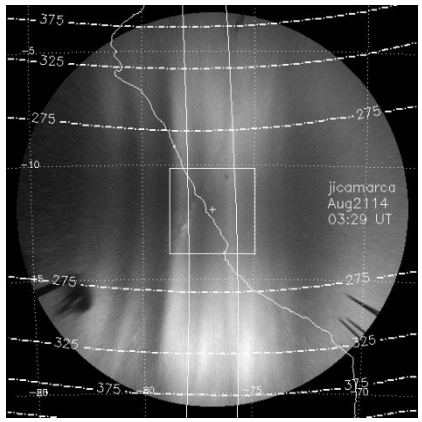

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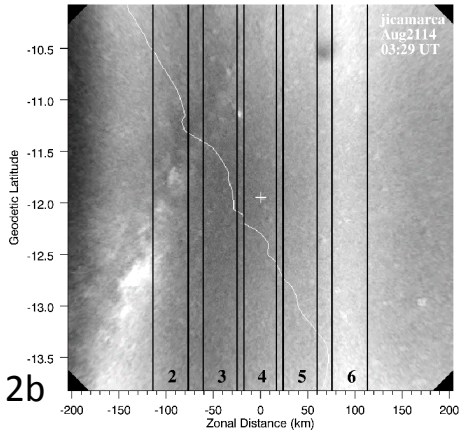

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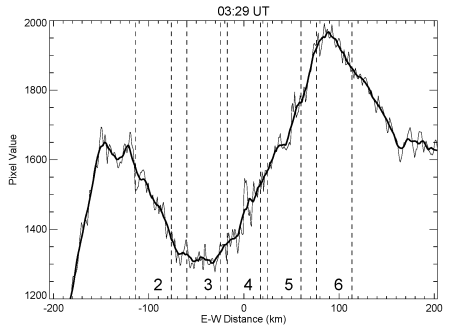

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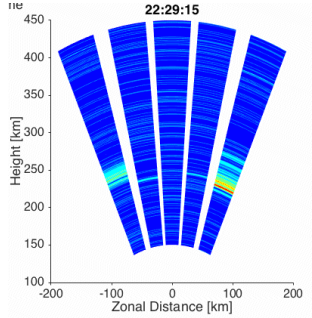
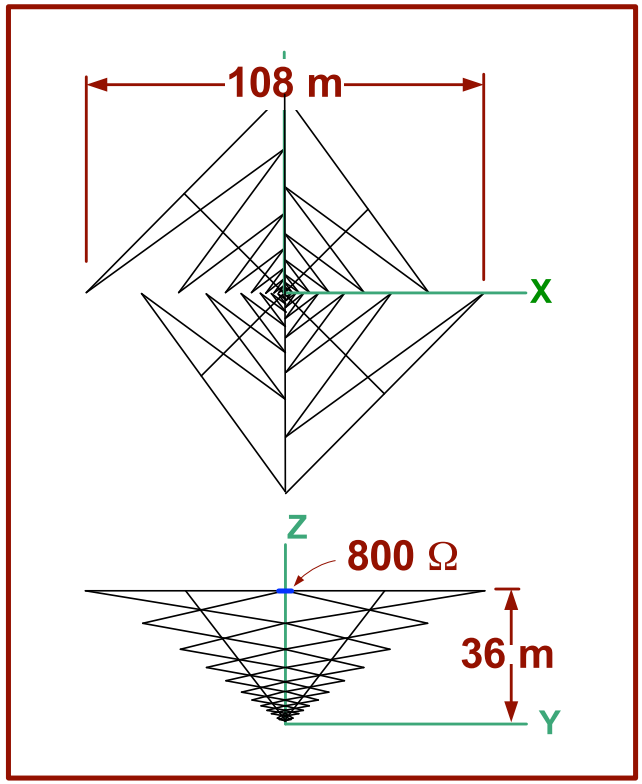


2d

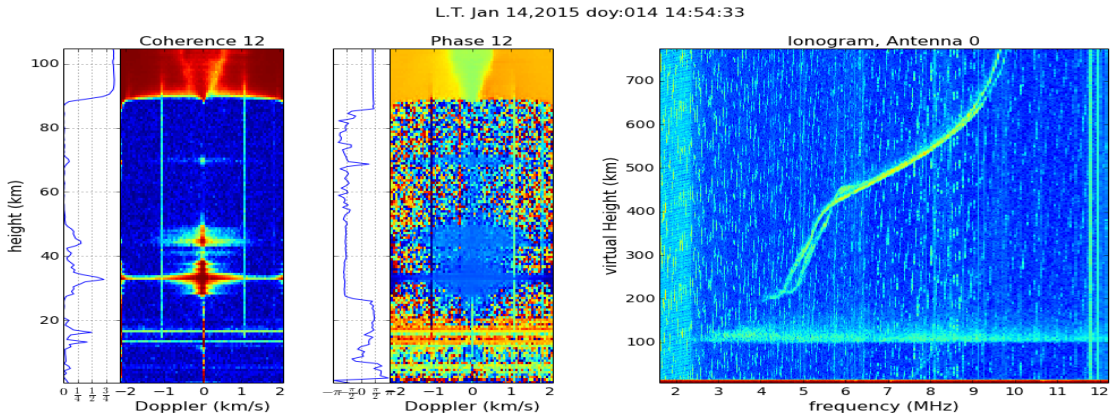
BU all-sky camera was installed at JRO in March 2014. The system can switch between 5 different filters (5577, 6300, 6950, 7774, 6050A). ESF observations taken with this system and AMISR (Aug 2014) are compared to study the relationship between air-glow structures and coherent scatter radar echoes.

Valley & 150km region studies using ISR and VIPIR

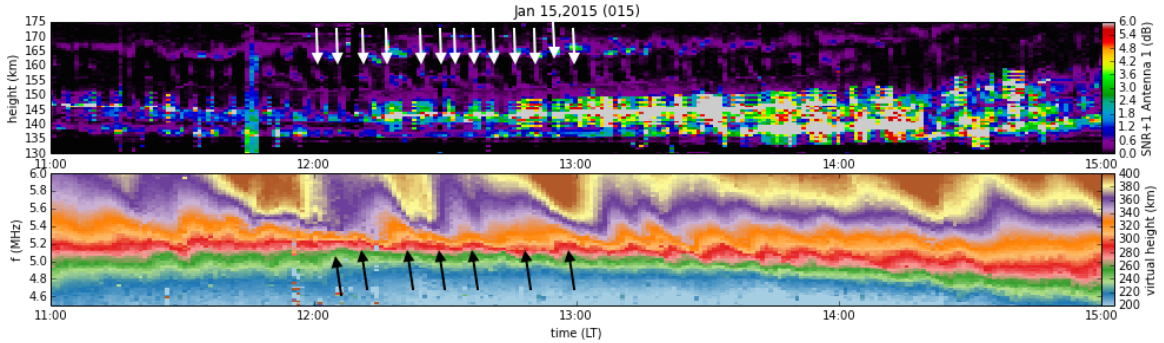


- VIPIR characteristics:
  - 1 Transmitter 0.3 - 30 MHz
  - 8 Receivers
    - Interferometric configuration
    - Orthogonal polarizations

Wideband ISR spectra and VIPIR ionogram:

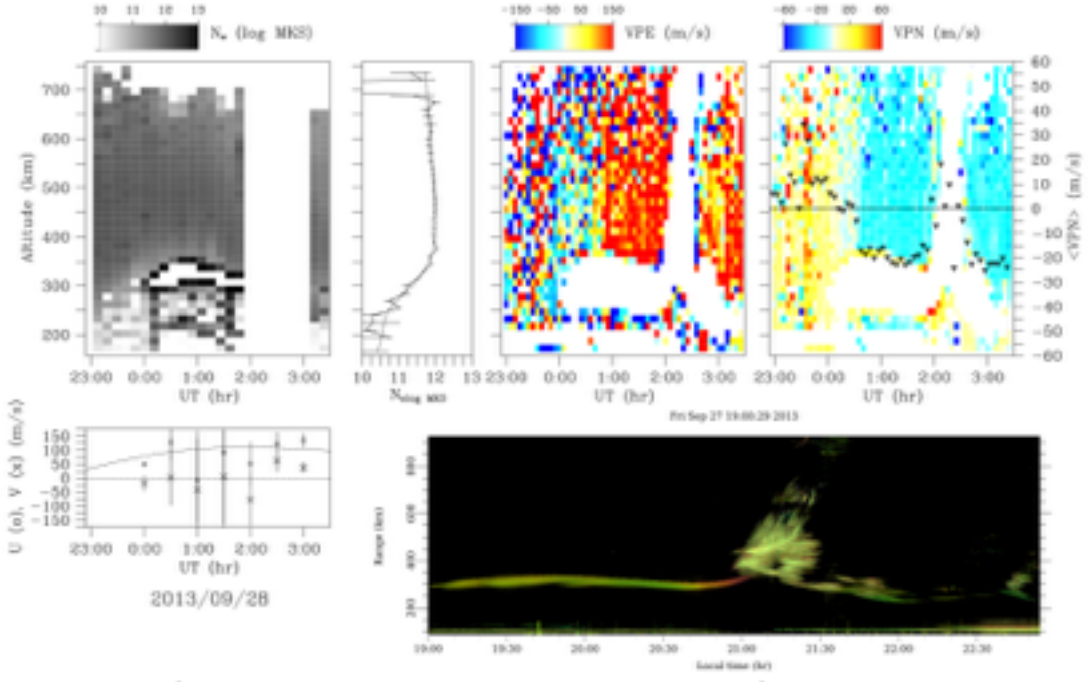


GWs and 150-km echoes:



Evidence of modulation of 150km echoes and F1 layers by gravity waves.

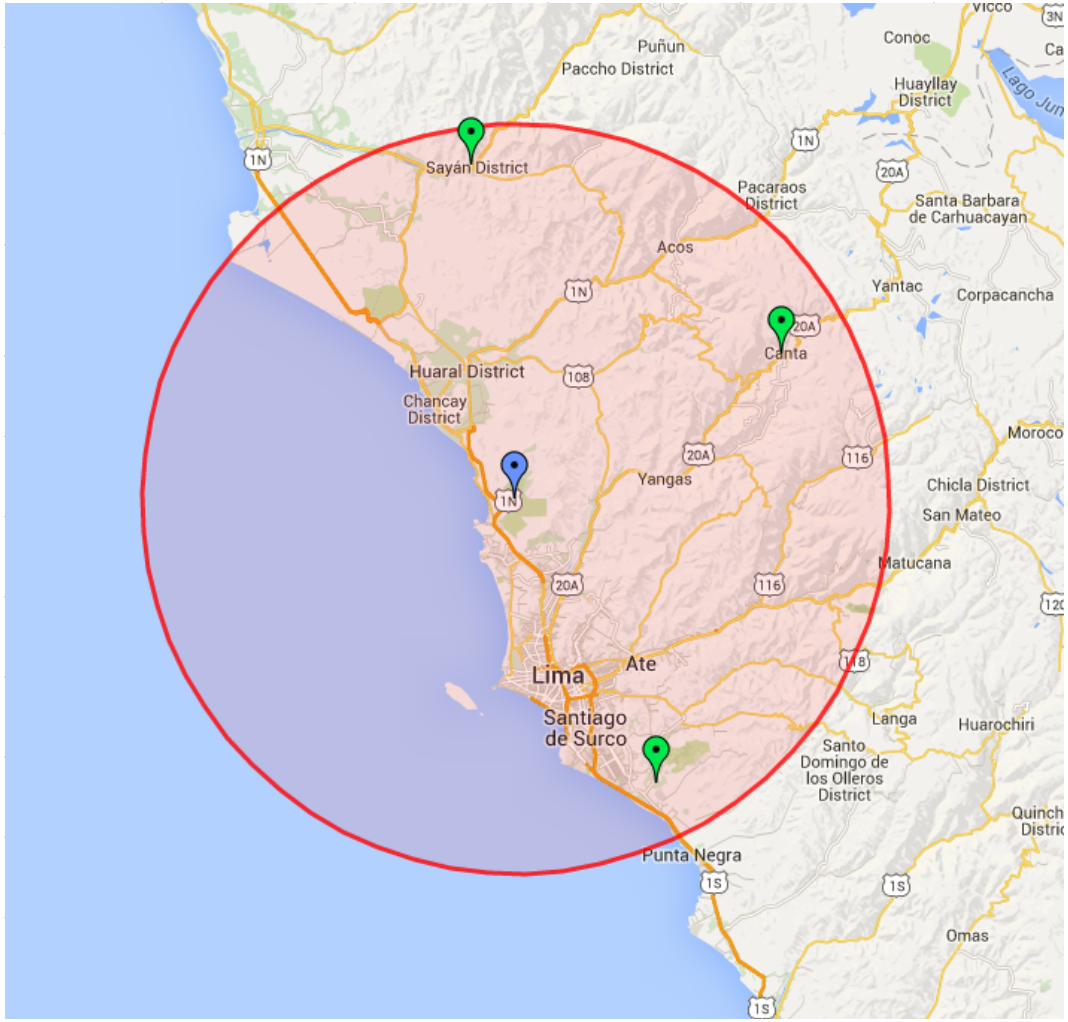
FPI winds and ISR measurements used for simulation of Spread-F initiation



Network of FPIs in Peru:

- 3 stations: JRO, Nazca, and Arequipa
- Operate in Cardinal and Common volume modes.
- Winds and temperatures are available in Madrigal

TIDDBIT will be back soon



- TIDDBIT is an HF Doppler sounding system used to detect traveling ionospheric disturbances (TIDs).
- 3 TX stations (Canta, Sayan, and Lurin)
- 1 RX station at Ancón.
- Tim Dully (ASTRA) and JRO engineers will be in charge of the deployment of TIDDBIT equipment next month.

JRO & Cluster of instruments

Instrument	Parameter	Region	Time Coverage	Annual Coverage	Regional Coverage
ISR	Ne, Te, Ti, Vz, Vx, %	Ionosphere	24h	1000 hours	JRO
MST	U,V,W	Troposphere, Stratosphere, Mesosphere	24h (T,S) Daytime (M)	> 10 days	JRO
JULIA	Irregularity intensity, Vz, Vx	Ionosphere	24h	4000 hours	JRO
JULIA-150	Vz	Ionosphere	Daytime	150 days	JRO
FPI (AQP, SOFDI, MRH)	U,V, Tn	Bottom *F* region	Nighttime Daytime (SOFDI)	> 100 days	Peru
Magnetometers (JRO, LISN)	Vz	Ionosphere	Daytime	365 days	77°, 75°, 69°, 56° West
LISN GPS	TEC, scintillations	Ionosphere	24h	365 days	South America
Ionosondes (JRO, LISN)	TEC, scintillations	Ionosphere	24h	365 days	77°W, 69°W
JASMET-Meteors	U, V	Mesosphere	24h	Campaigns	JRO, HYO (*)

JRO Tour