Geospace activities at the Geophysical Institute of Peru

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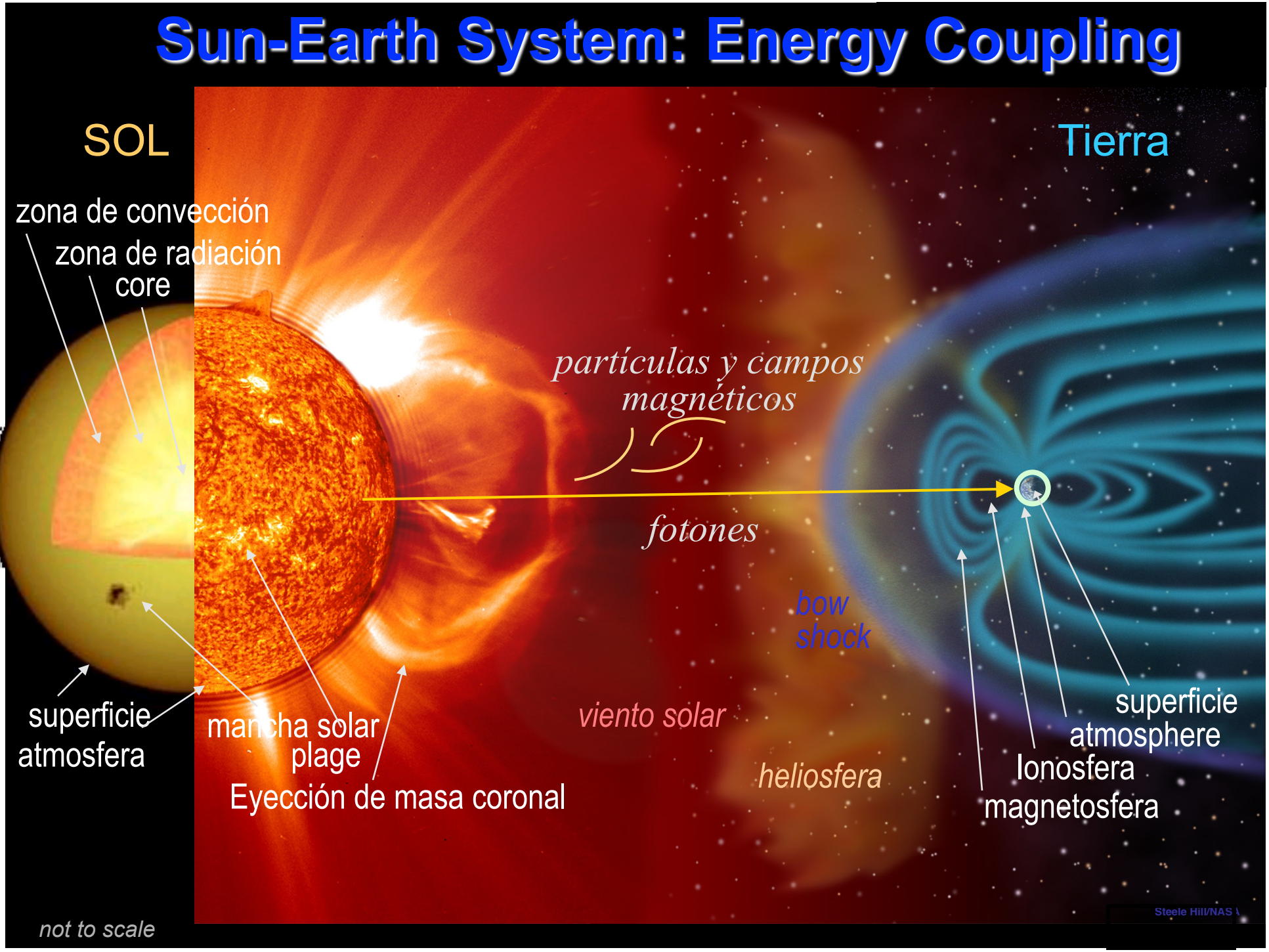
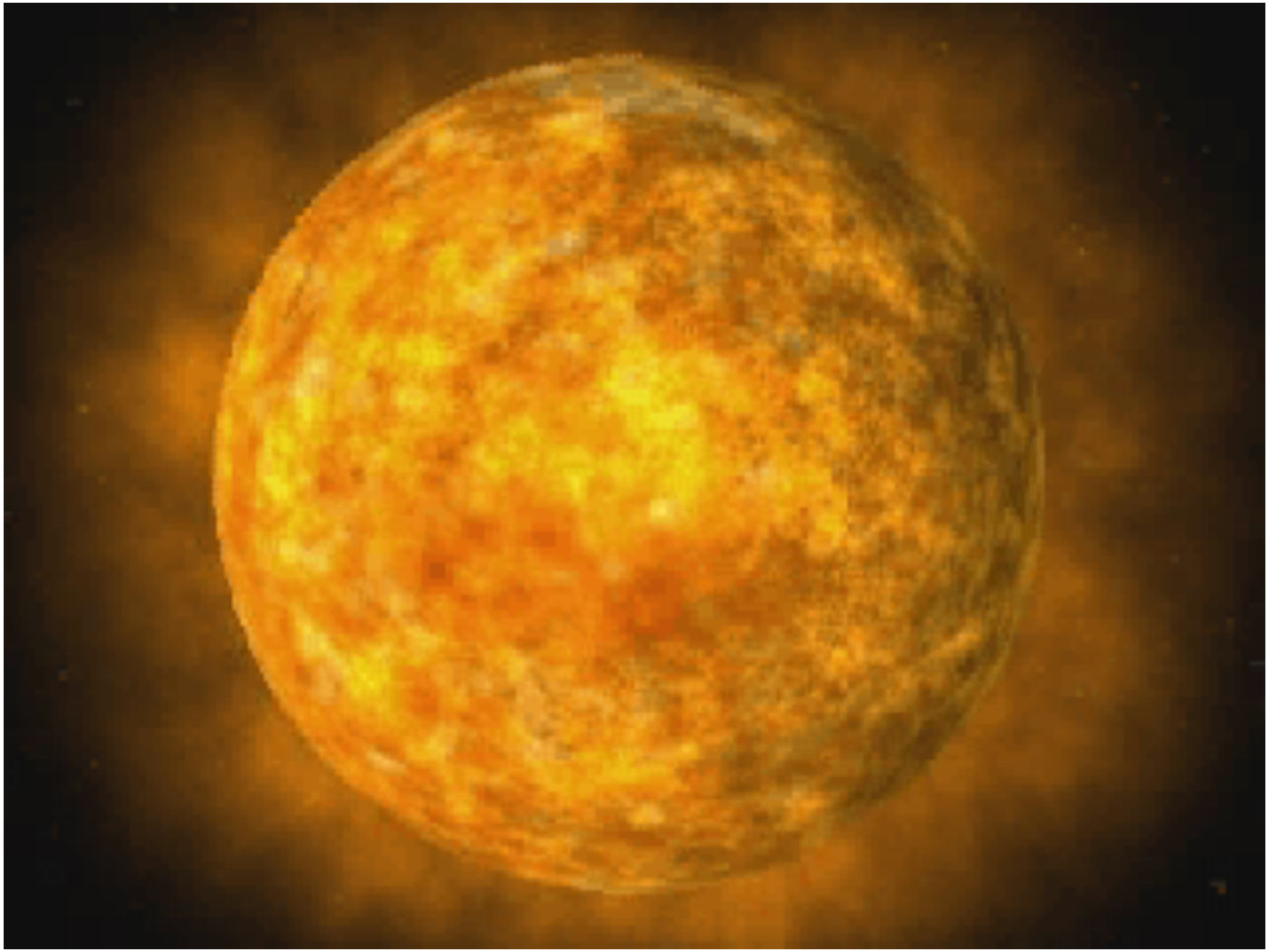
Outline

- Space Weather and Equatorial Aeronomy
- Clustered Instruments
  - Incoherent and Coherent Scatter Radars
  - LISN
  - Magnetometers
  - Optical Instruments
  - Solar and Astronomical Instruments
- Equatorial and Low latitude Ionospheric Effects due to Planetary Wave Atmospheric forcing

Sun-Earth System: Energy Coupling

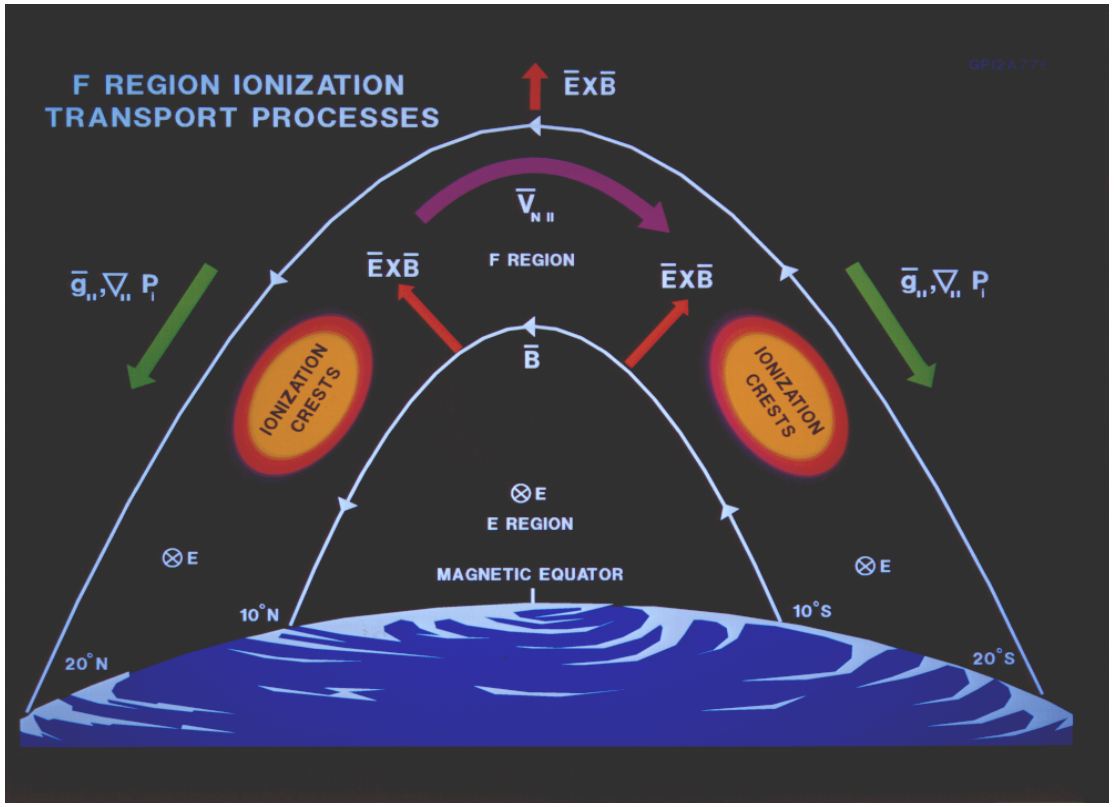


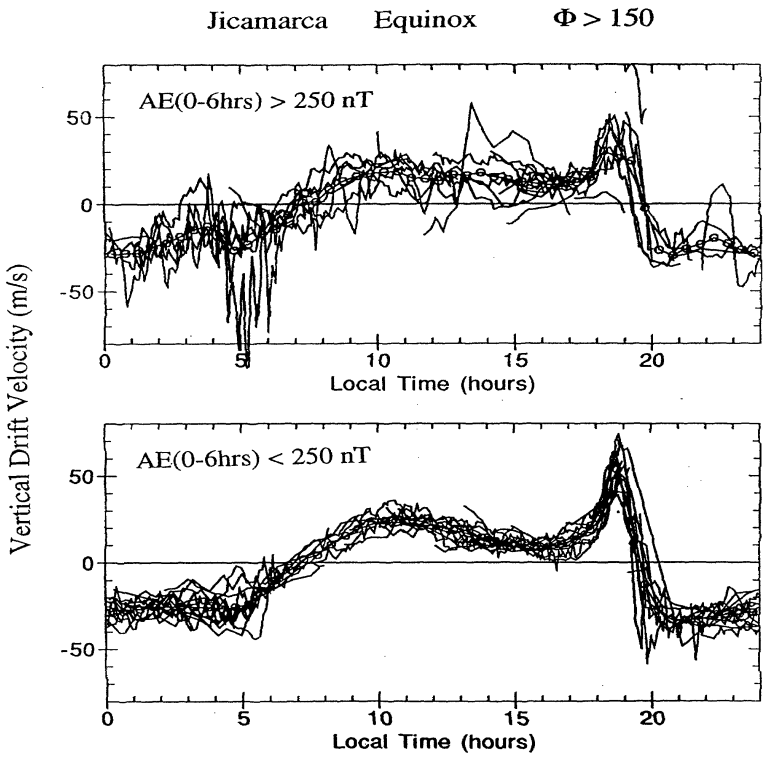
Space Weather: Artist View



[Courtesy *Su. Basu*, CAWSES]

Equatorial Ionosphere





[from *Fejer et al*, 1999]

- **B** field is nearly horizontal
- Daytime:
  - *E*-region E is eastward
  - Off-equatorial E maps to F above mag. Equator -> Upward ExB
  - Formation of Appleton Anomaly
- Around sunset, *F* region dynamo develops and competes with *E*, generates PRE and ExB goes downward (E westward)
- At night upward density gradient is opposite in direction to g, Rayleigh-Taylor unstable, allowing plasma density irregularities to form.

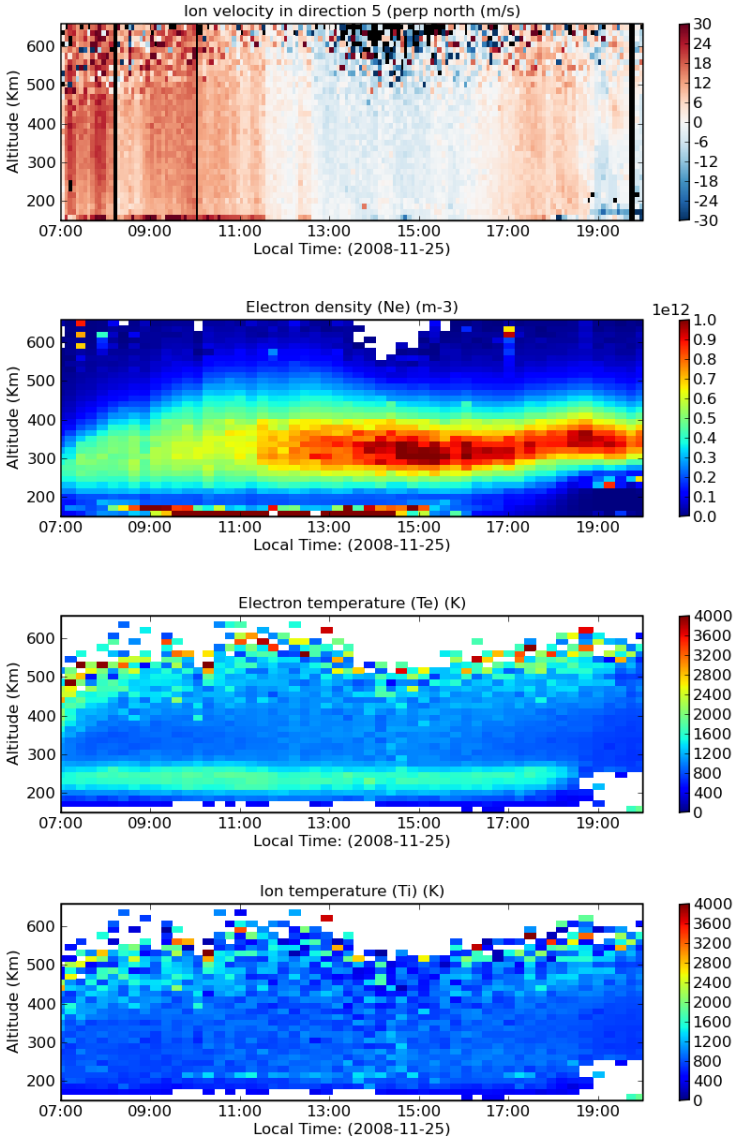
JRO-IGP Clustered Instruments

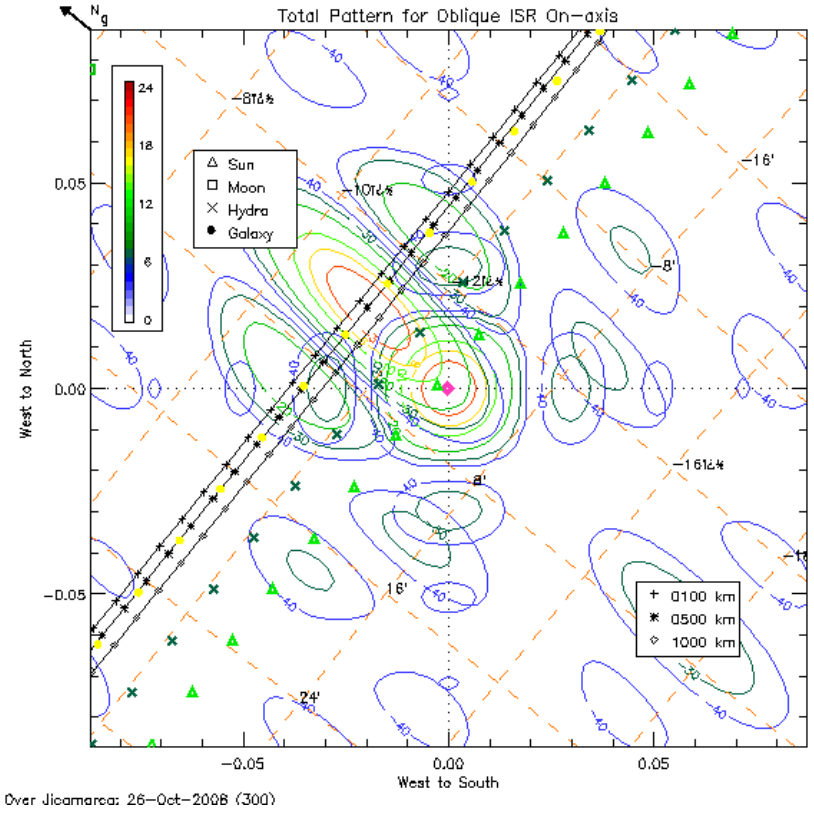
Instrument	Parameter	Region	Time Coverage	Annual Coverage	Regional Coverage	TG4 Projects
ISR	Ne, Te, Ti, Vz, Vx, %	Ionosphere	24	1000 hours	JRO	1,2,3,4
MST	U,V,W	Troposphere, Stratosphere, Mesosphere	24 (T,S), daytime (M)	> 10 days	JRO	1,3
JULIA	Irregularity intensity, Vz, Vx	Ionosphere	24	4000 hours	JRO	2,3
JULIA-150	Vz	Ionosphere	Daytime	150 days	JRO	1,3,4
FPI (AQP, SOFDI, MRH)	U,V, Tn	Bottom *F* region	Nighttime Daytime (SOFDI)	> 100 days	Peru	2
Magnetometers (JRO, LISN)	Vz	Ionosphere	Daytime	365 days	77°, 75°, 69°, 56° West	1,3,4
LISN GPS	TEC, scintillations	Ionosphere	24	365 days	South America	1,2,3
Ionosondes (JRO, LISN)	TEC, scintillations	Ionosphere	24	365 days	77°W, 69°W	1,2,3
JASMET-Meteors	U, V	Mesosphere	24	Campaigns	JRO, Piura, HYO (*)	1,3

CAWSES II Task Group 4

- What is the geospace response to variable inputs from the lower atmosphere?
  - Project 1: How do atmospheric waves connect tropospheric weather with ITM variability?
  - Project 2: What is the relation between atmospheric waves and ionospheric instabilities?
  - Project 3: How do the different types of waves interact as they propagate through the stratosphere to the ionosphere?
  - Project 4: How do thermospheric disturbances generated by auroral processes interact with the neutral and ionized atmosphere?

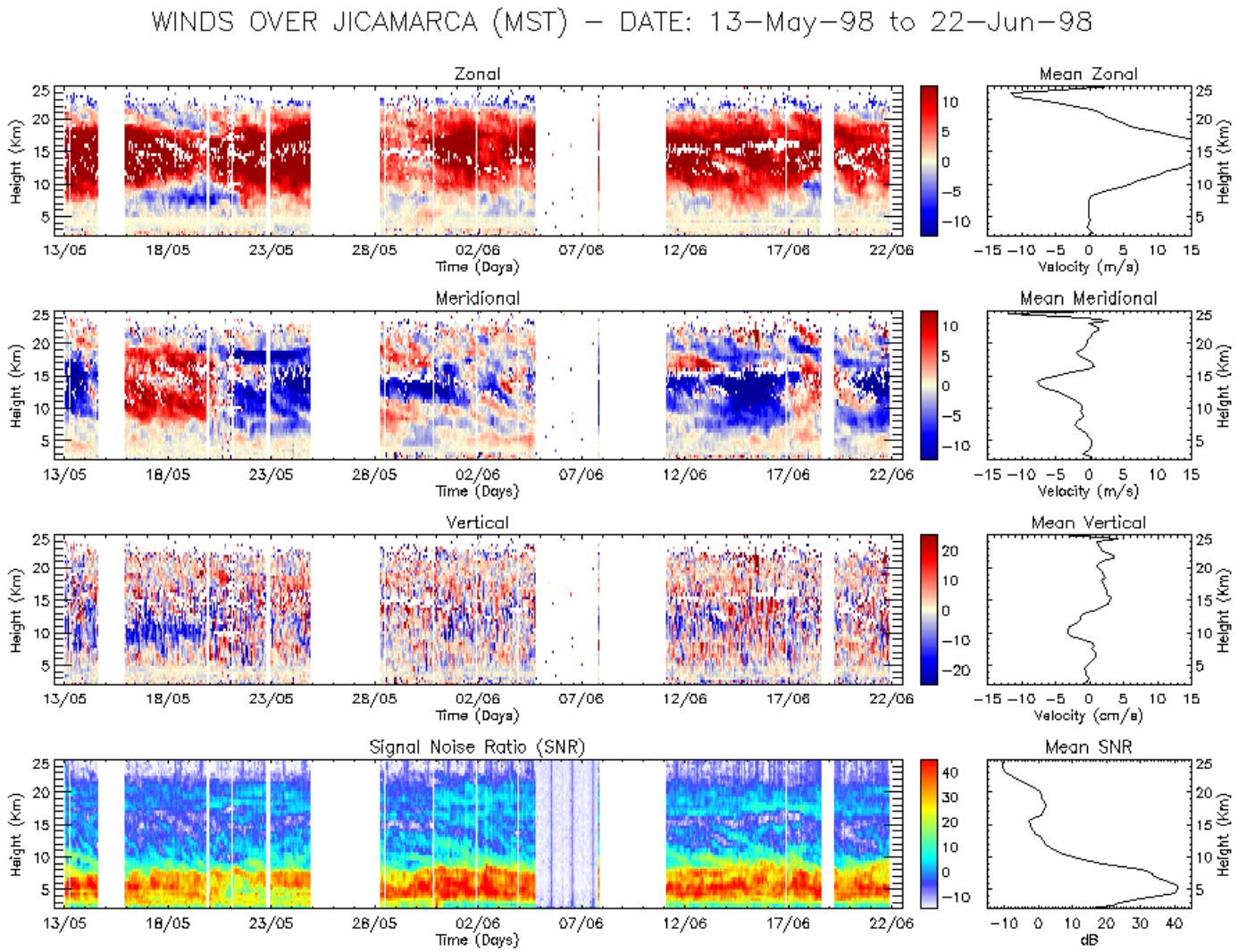
ISR Oblique + Perpendicular ("Odile" Mode)



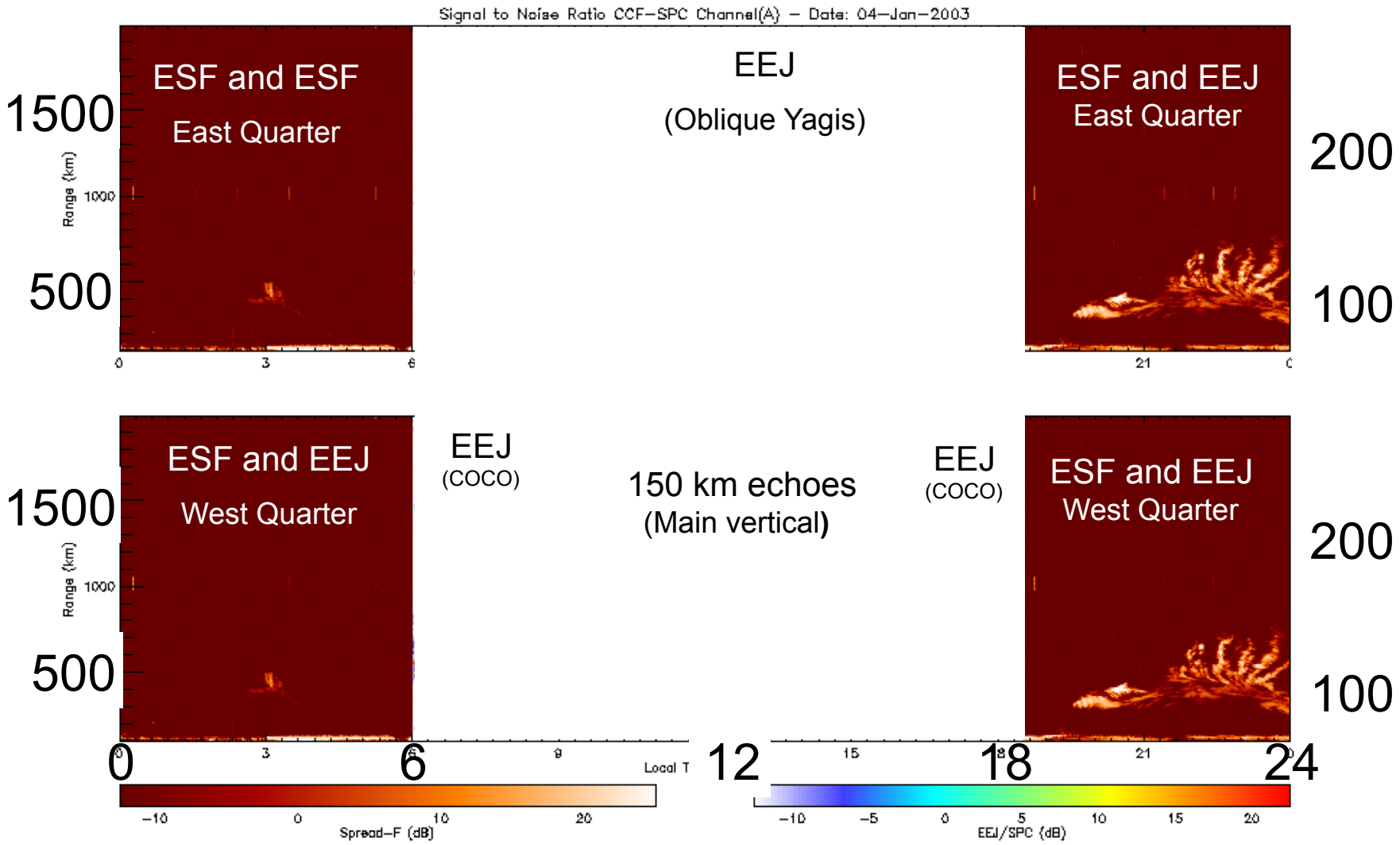


Oblique: Two txs, two polarizations, NS quarters
Perpendicular: One tx, two polarizations, EW quarters

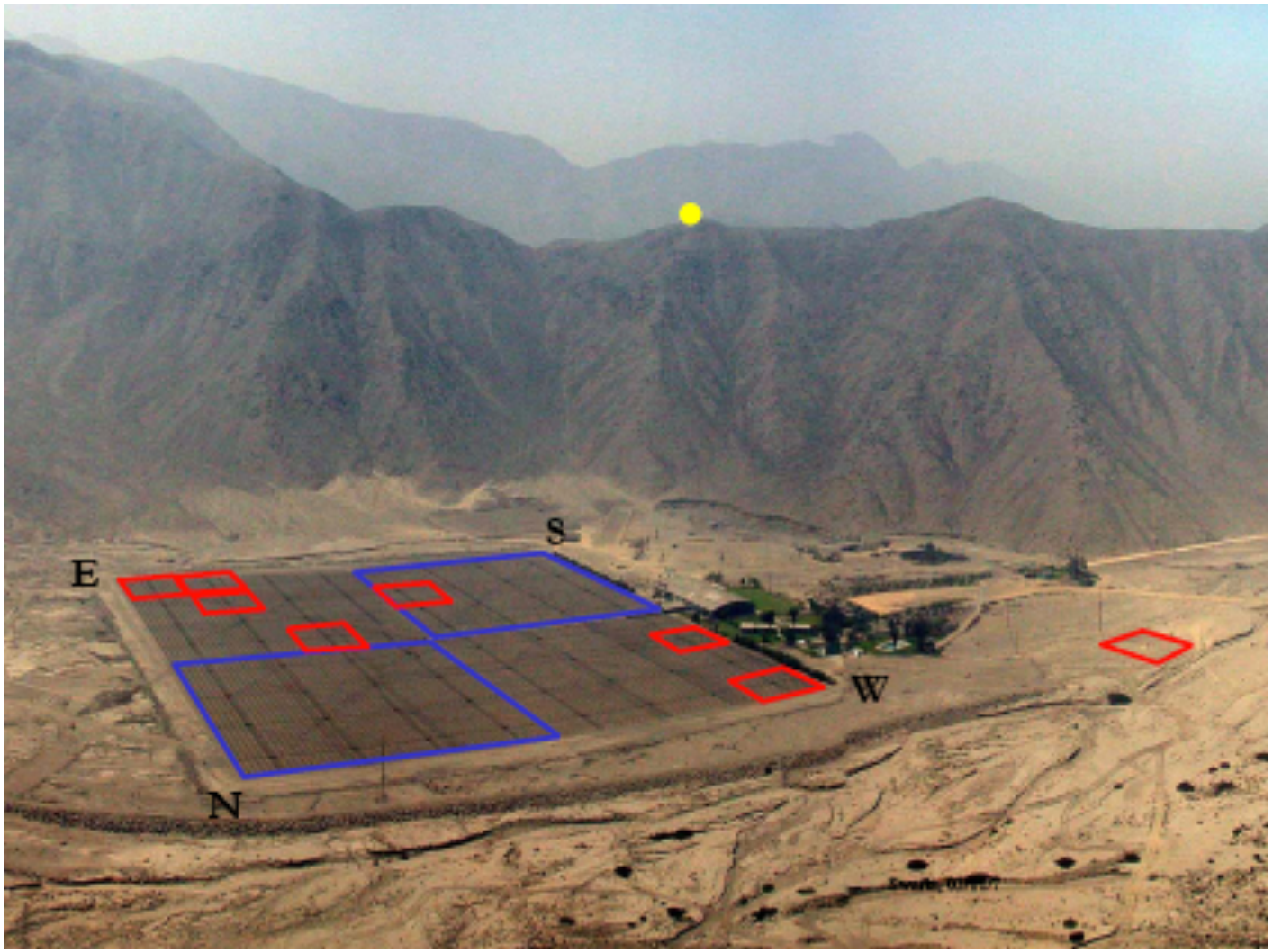
MST: Lower Atmosphere Winds



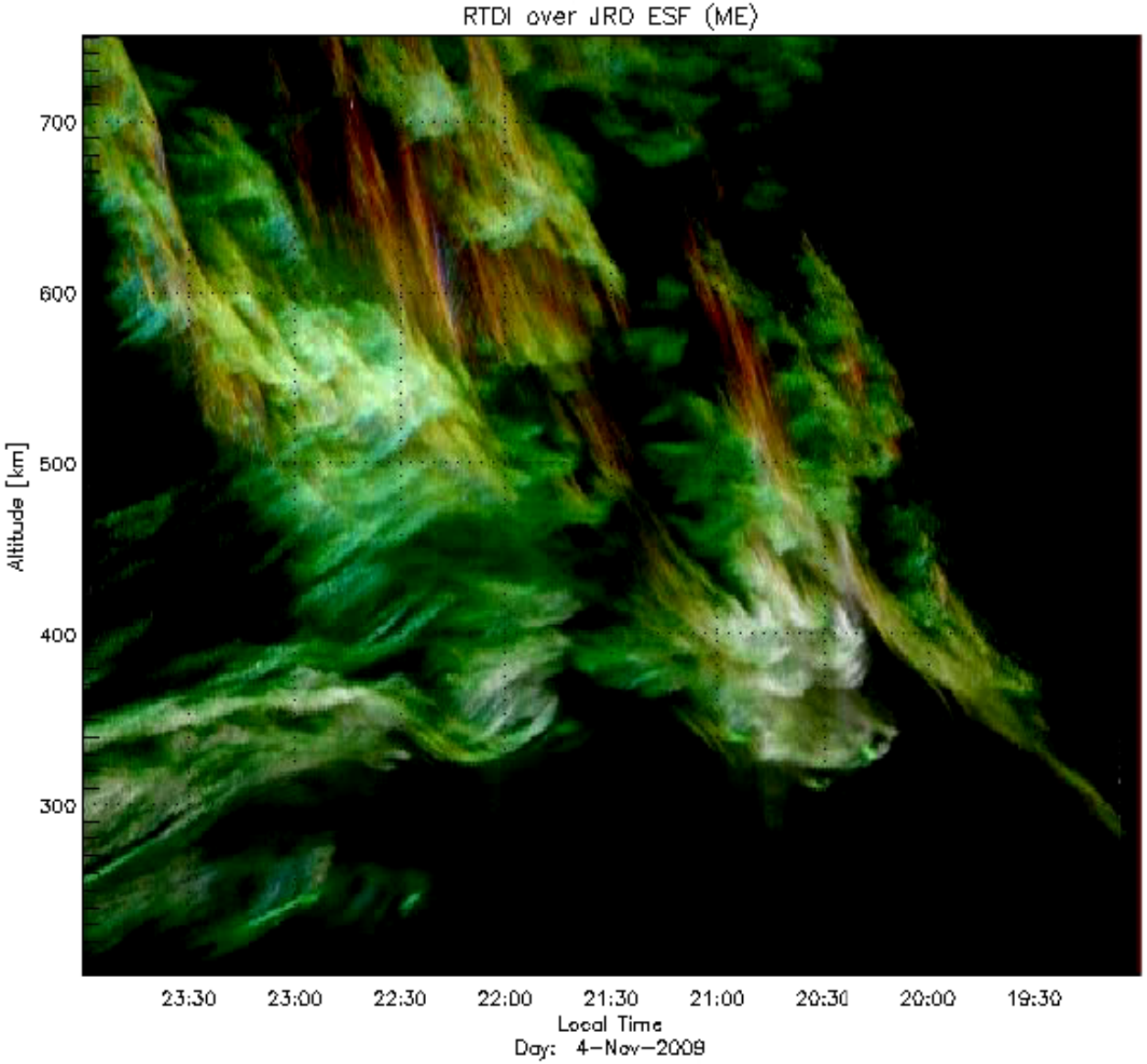
JULIA Observations

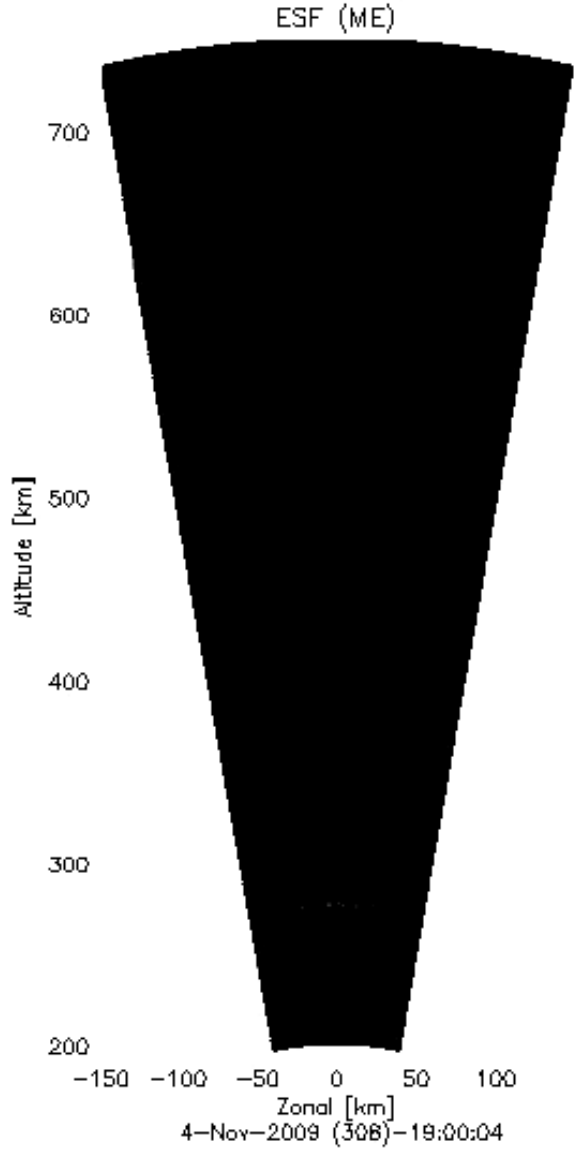


JULIA – Imaging (1)

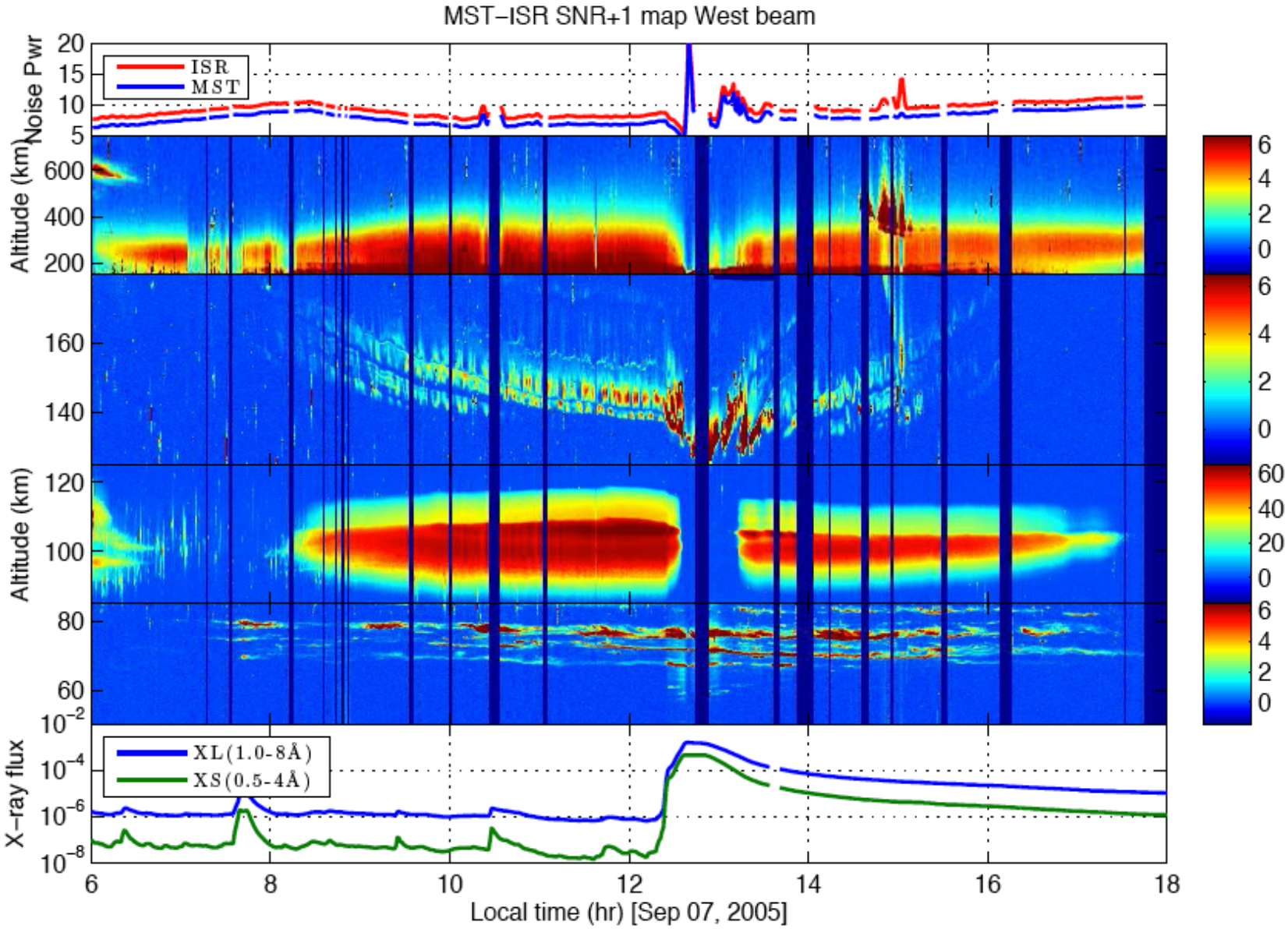


JULIA – Imaging (2)

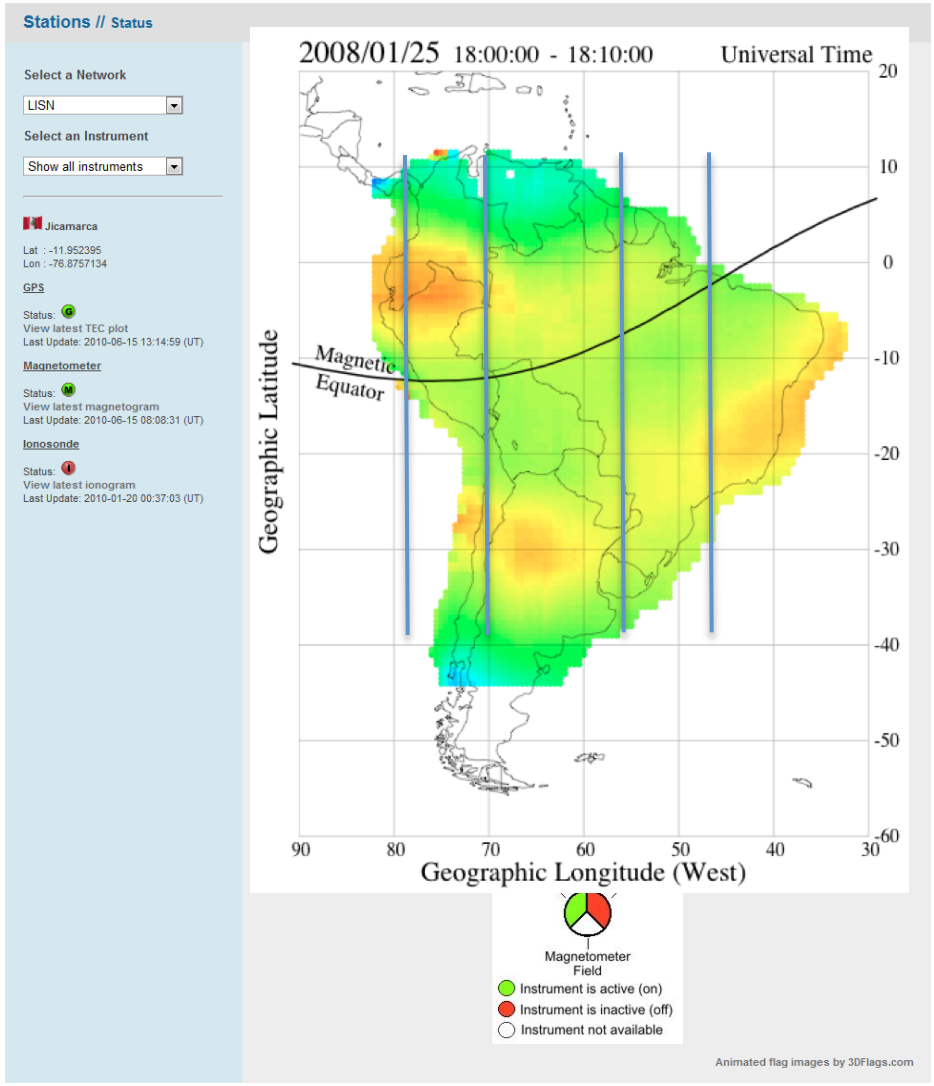


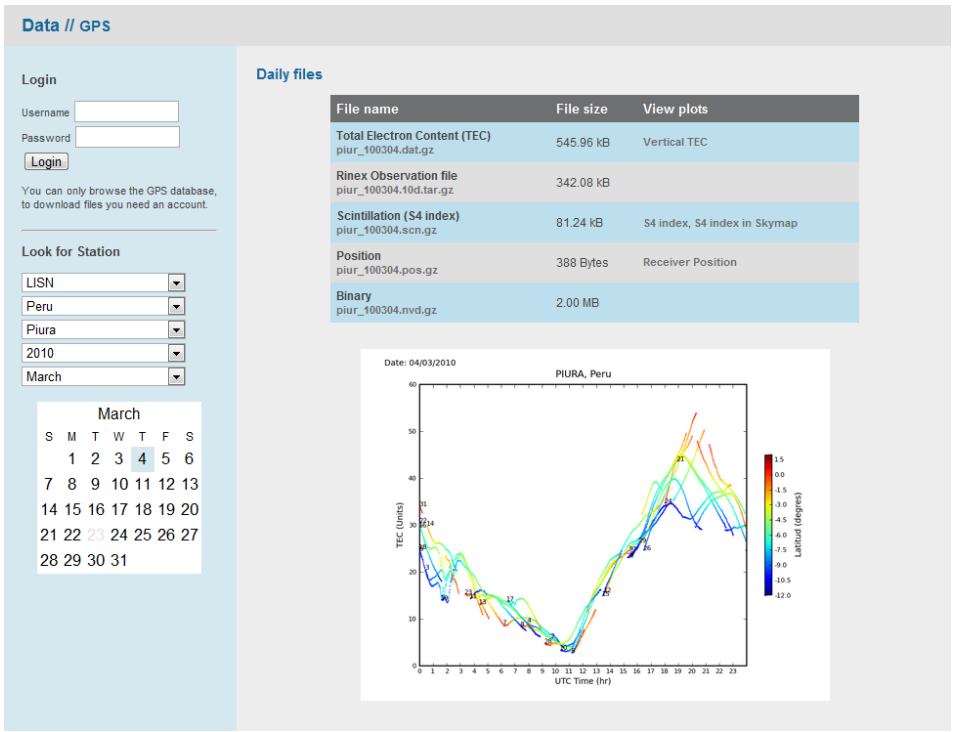


Solar Flare Effects on Radar Observations



LISN: Instruments + Database





http://200.60.148.173/lisn/gps

GEOMAGNETISM

HUANCAYO GEOMAGNETIC OBSERVATORY

GEOPHYSICAL INSTITUTE OF PERU

GEOMAGNETISM

GEOMAGNETIC OBSERVATORORIES BEFORE 1923

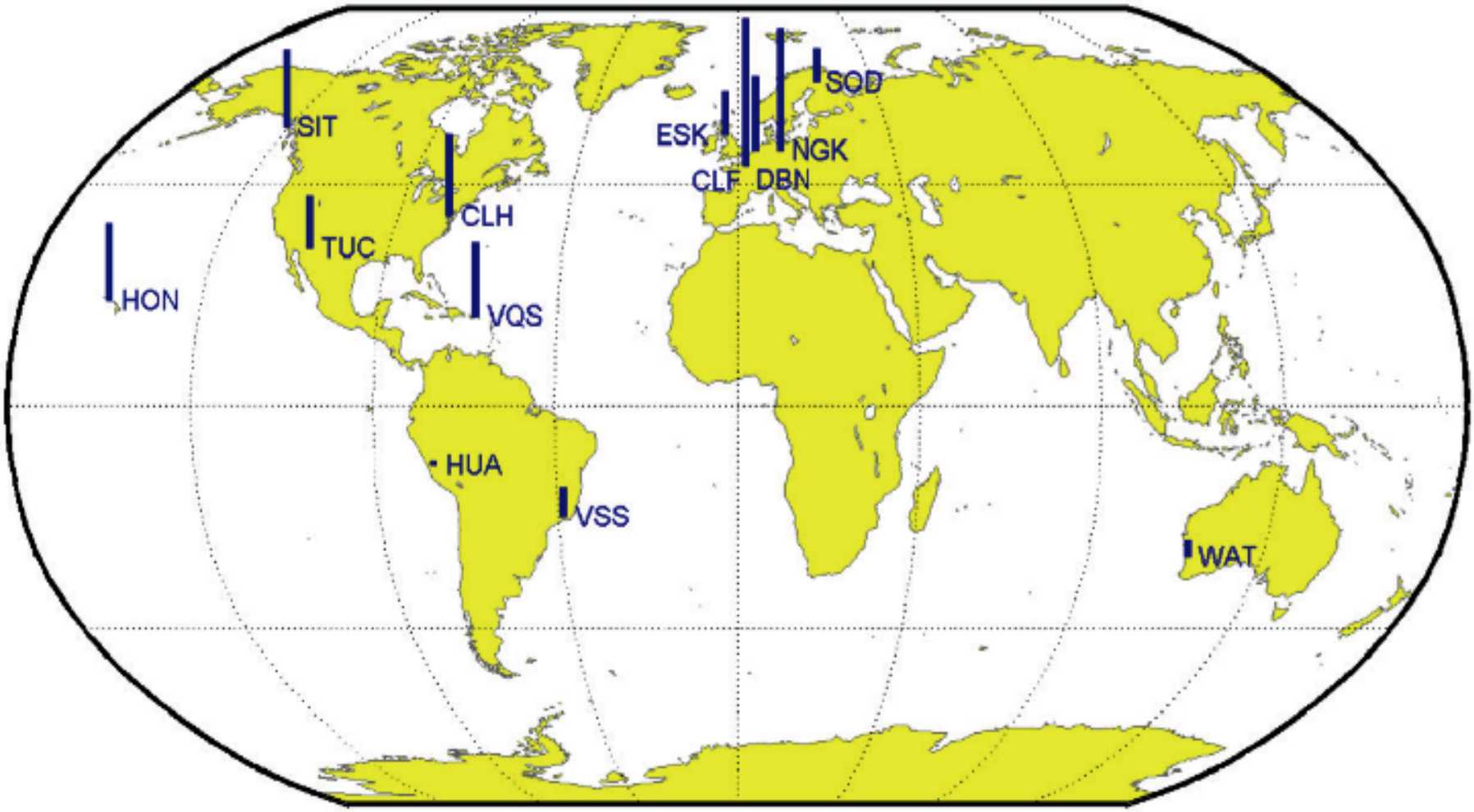
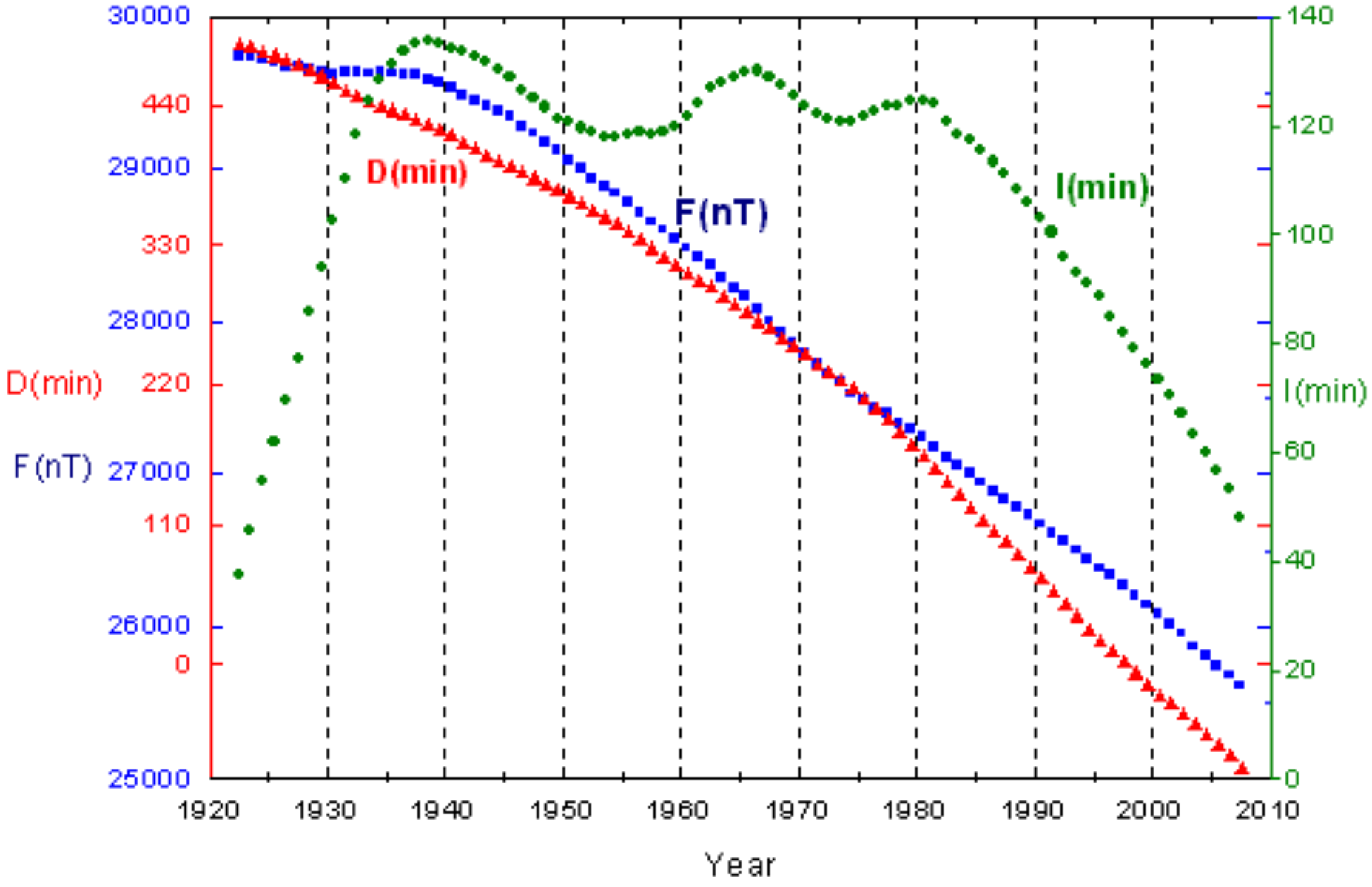


Figure 10: Longest continuous series of hourly values before 1923 available in digital format at WDC-C1.

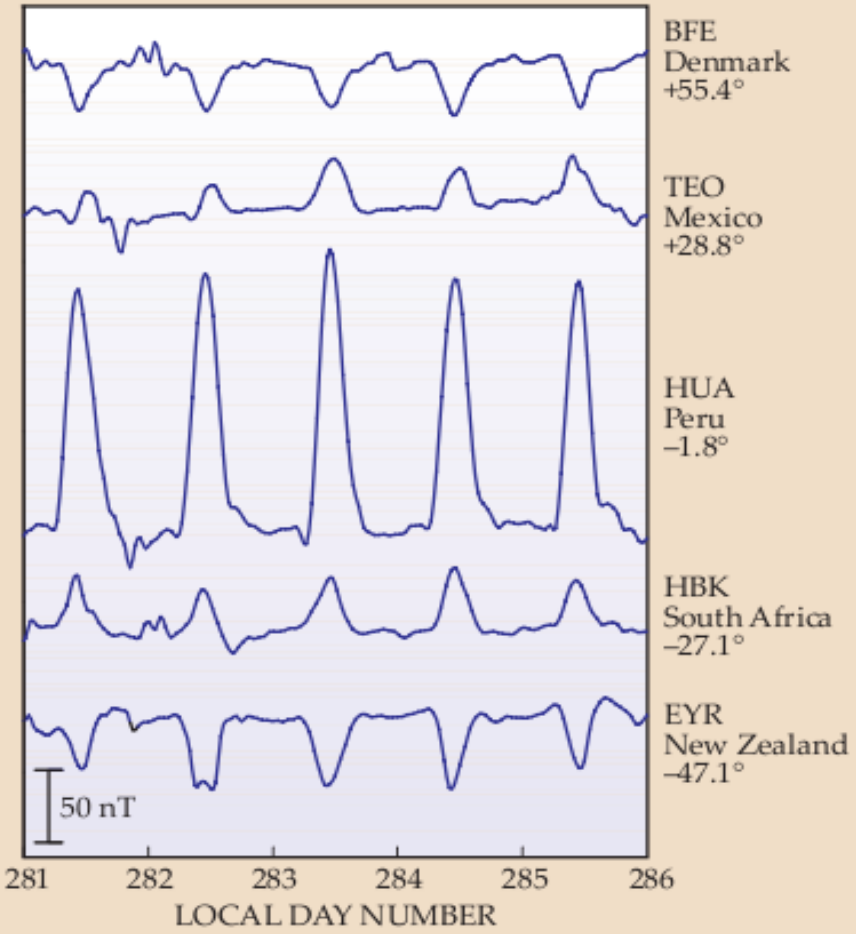
GEOMAGNETISM

HUANCAYO ANNUAL MEAN FROM 1922 TO 2009



GEOMAGNETISM

DIURNAL VARIATION PROMINENT FOR HUANCAYO



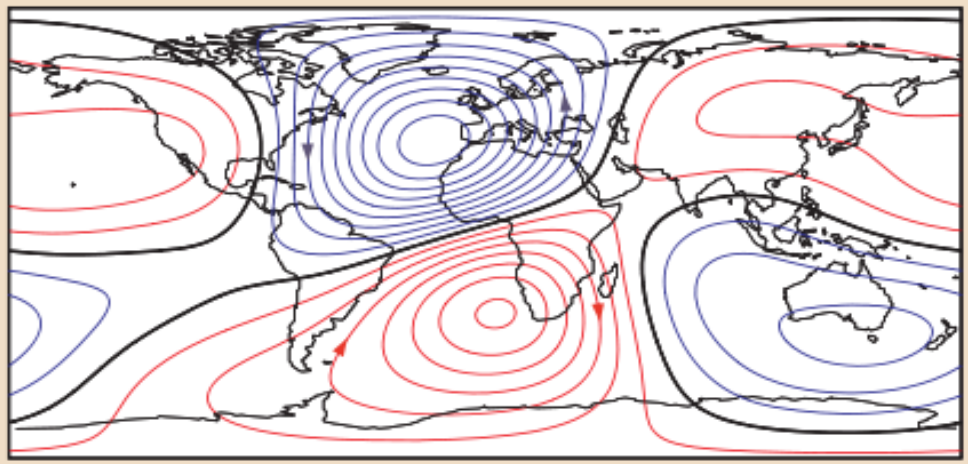
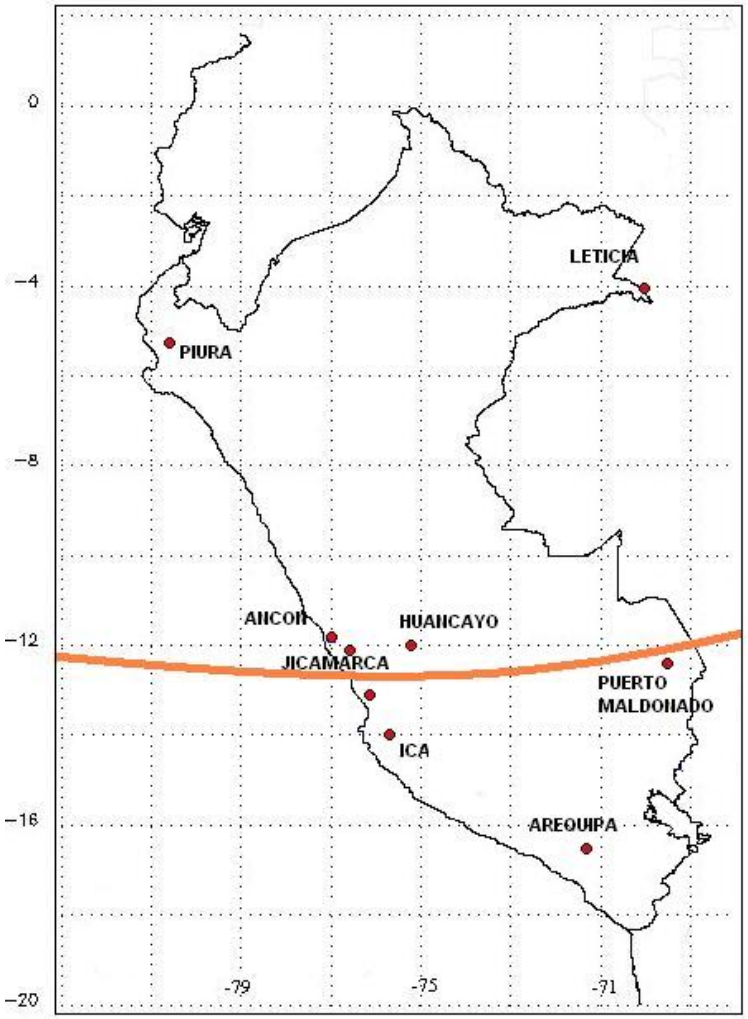


Figure 5. Magnetograms recording quiet times. (a) Data from five observatories show the horizontal intensity *H* for 8–12 October 2003. The magnetograms are arranged by geomagnetic latitude, which is measured relative to the axis of Earth's tilted dipole. Diurnal variation is prominent, especially for the Huancayo (HUA) observatory located near the magnetic equator. Note the change in polarity of the variation at high latitudes. **(b)** Observatory data can be used to map the electric currents in the ionosphere that sustain quiet-time variation. Shown here is a map for noon, Greenwich Mean Time. Contour lines indicate 10-kA increments; more densely packed contour lines indicate higher local current density. Red contours indicate clockwise-circulating current; blue contours, counterclockwise current.

SOURCE: Jeffrey J. Love, Magnetic Monitoring of Earth and space, U. S. Geological Survey, Physics Today, February 2008.

IGP Magnetometer Network 2009

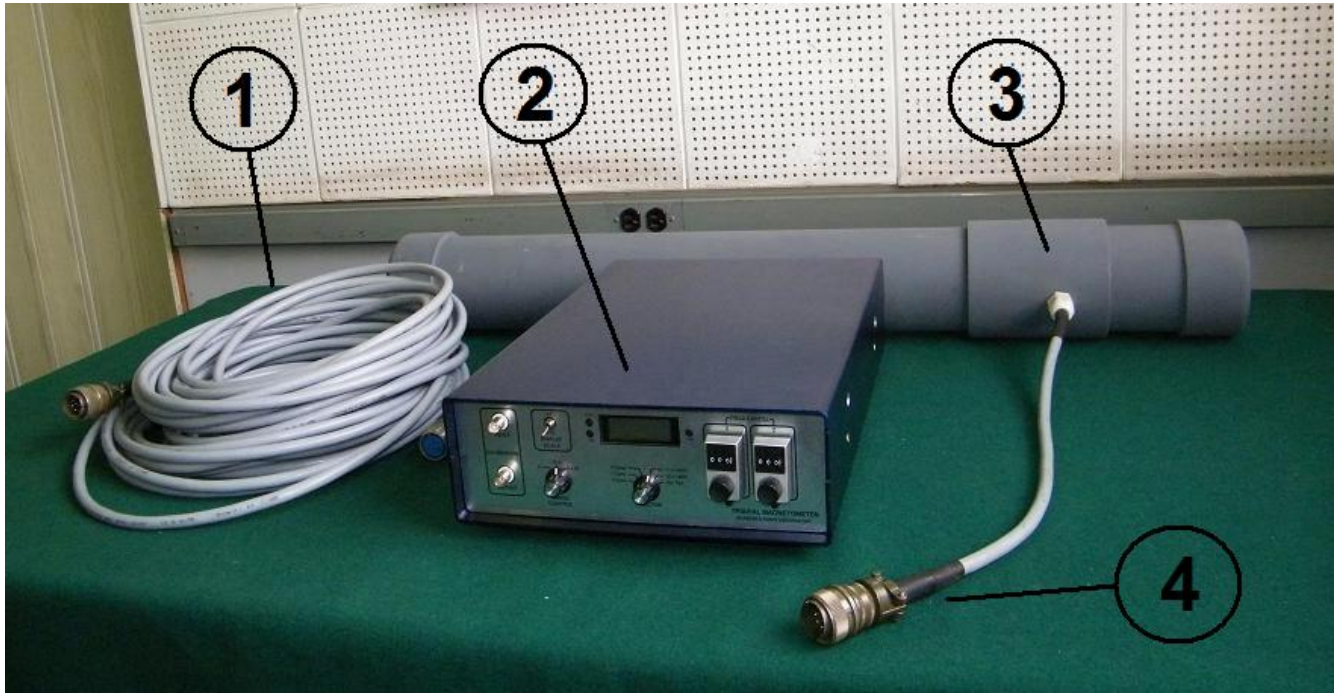
PIURA (-5.17 – 80.67)	XYZ Fluxgate (Tromso-IGP)
ANCON (-11.77 -77.14)	XYZ Fluxgate (MAGDAS) HDZ Fluxgate (Tokyo Univ.-IGP)
HUANCAYO (-12.03 -75.32)	H,D,Z Eschenhagen (DTM) HDZ Fluxgate (GRL-Tokyo-IGP) XYZ Fluxgate (ERI Tokyo) PPM (OHBM) *
JICAMARCA (-11.56 -77.03)	XYZ Fluxgate (UCLA-IGP)
CAÑETE (-13.11 -76.38)	XYZ Fluxgate (KYU Univ.) CPMN Project
ICA (-13.98 -75.77)	XYZ Fluxgate (KYU Univ.) CPMN Project
AREQUIPA (-16.46 -71.49)	H,D,Z La Cour, Photographic, (UNSA)
PTO. MADONADO (-12.58 – 69.18)	XYZ Fluxgate (LISN – IGP)
LETICIA (-4.19 -69.94)	XYZ Fluxgate (LISN-Colombia)



IGP Magnetometer Network: Collaboration

- MAGDAS, Kyushu (Ancon 2002)
- CPMN, Kyushu U. (ANC, CNT, GUA – 1994)
- OHBM, ERI U. Tokyo, (HUA – 1997)
- INTERMAGNET, (HUA. 2003)
- SMALL UCLA U. (Jicamarca 1997)
- LISN, (P. Maldonado, Leticia, Casleo 2008)
- IGP, (DeltaH JIC-PIU) , 2000

MAGNETOMETRO ROJ MAG-103



1- 25m Cable

2- Control Unit

3- XYZ Sensor

4- Sensor Conn.

Total measurement range	:	+/- 75000 nT
Dynamic range, three selectable	:	+/- 2500 nT, 1000nT, 250nT
Sensitivity	:	2.5mV/nT
Resolution	:	0.1 nT
Supply voltages	:	+12 Vdc / 220Vac
Current consumption	:	+320 mA
Analog output voltage	:	+/- 2.5 V full
Digital output	:	USB

JRO Databases: ISR, JULIA, ΔH

JRO Madrigal data access

Instrument: Jicamarca IS Radar 1994–2009

Experiment: All experiments

Year: 2009

Month: May

May 2009

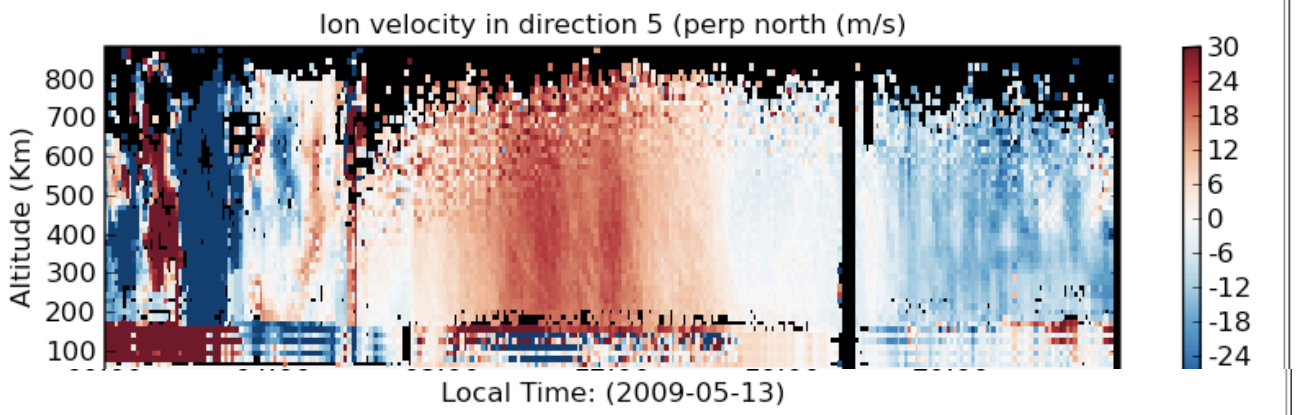
Sun	Mon	Tue	Wed	Thu	Fri	Sat
26	27	28	29	30	01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	01	02	03	04	05	06

Simple Madrigal data access - select option...

Selected Instrument:	Selected Experiment:	Selected dates:
• *Jicamarca IS Radar*	Drifts	• 2009-05-13

plot Data | print Data | download File | view Header&Catalog

Choose parameter to plot:	Ion velocity in direction 5 (perp north
Select y axis:	Altitude

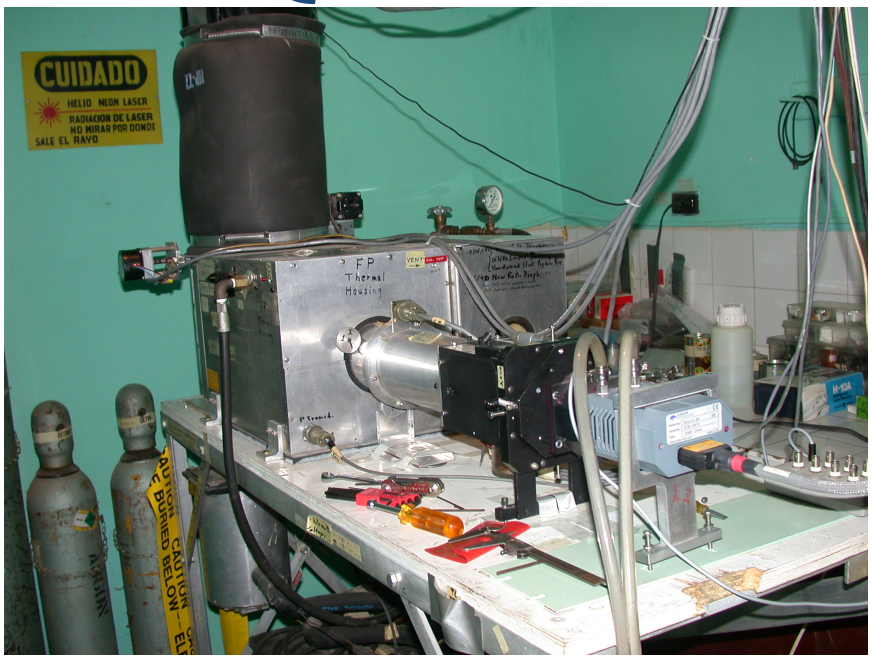


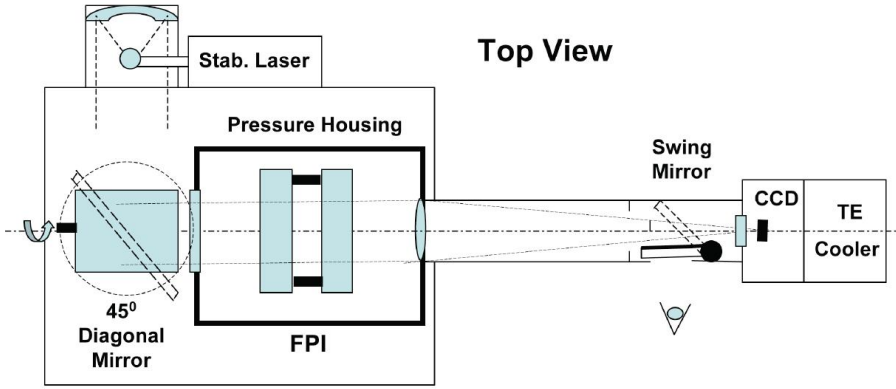
Advanced Filters

Time:	00 - 24	○ Time-Average
Altitude:	0.0 - 885.0	○ Height-Average
ColorMap Range:	-30.0 - 30.0	◉ Disabled-Average

Apply | Reset

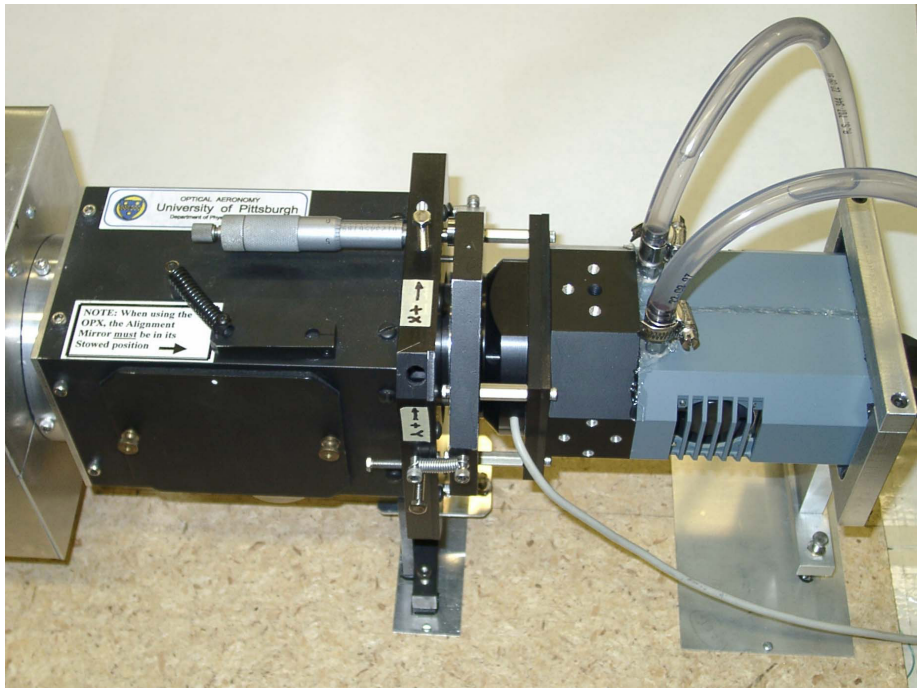
AREQUIPA A3O FPI - CLEMSON





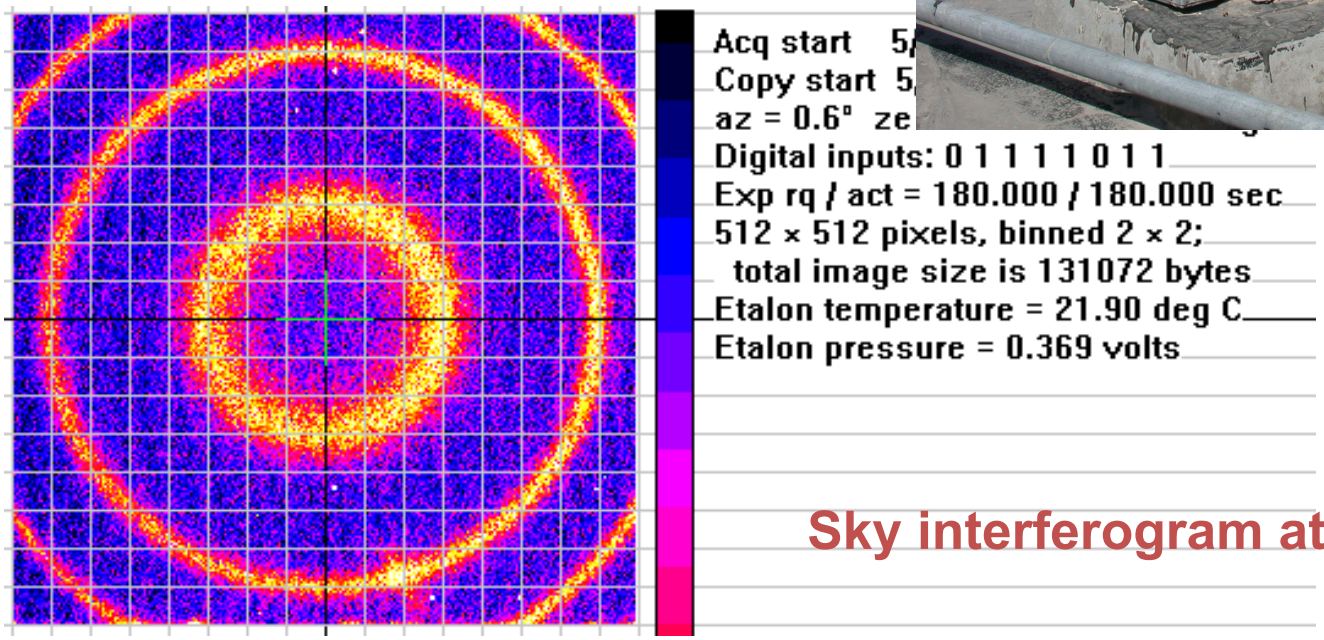
Internal View

- Pressurized Camera Etalon FPI
- Optical system: lens 54cm
- Filters: 630nm y 732nm
- CCD camara Andor DU412
  Chip CCD 512x512



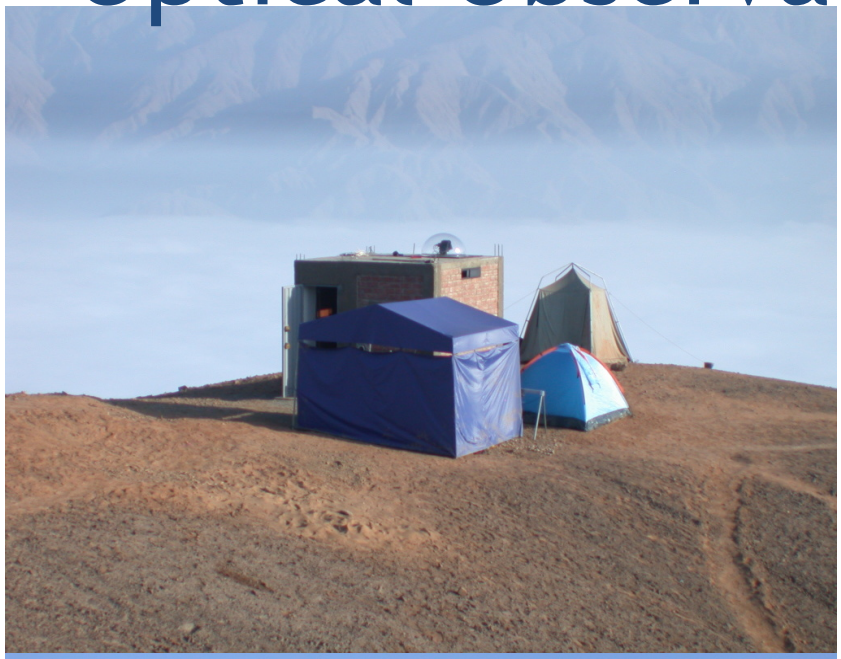
AREQUIPA A3O FPI - CLEMSON

Automatic Sky Scanner
- **Azimuth 0°-180°**
- **Zenith -90° 0 +** 90°



Sky interferogram at 630nm

Optical Observatory JRO-MRH



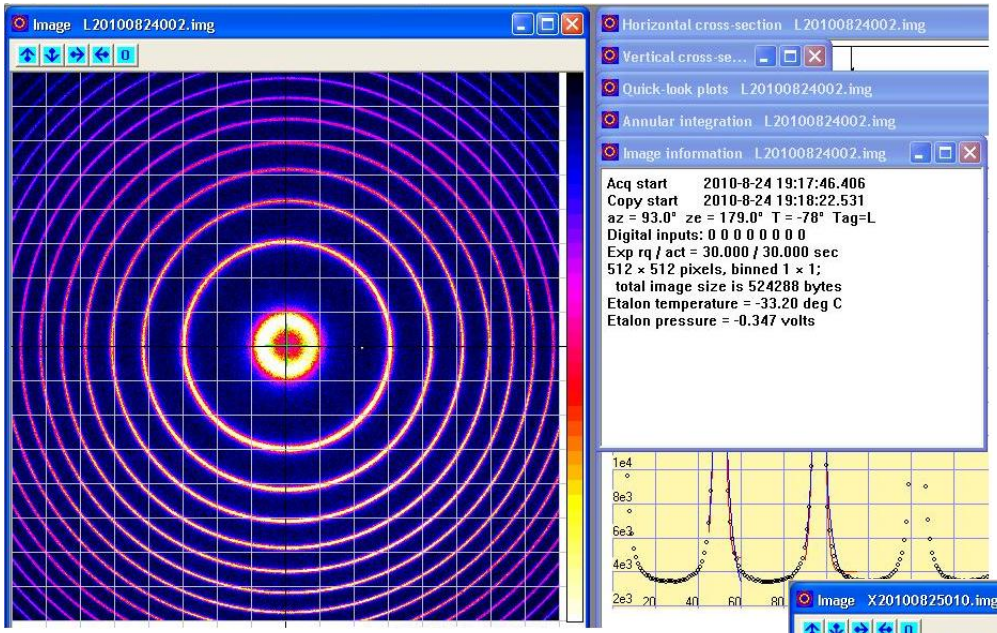
Location

Lat. 11 57 31.4 S
Long. 76 51 36.8 W
Alt. 1092 msnm

Features

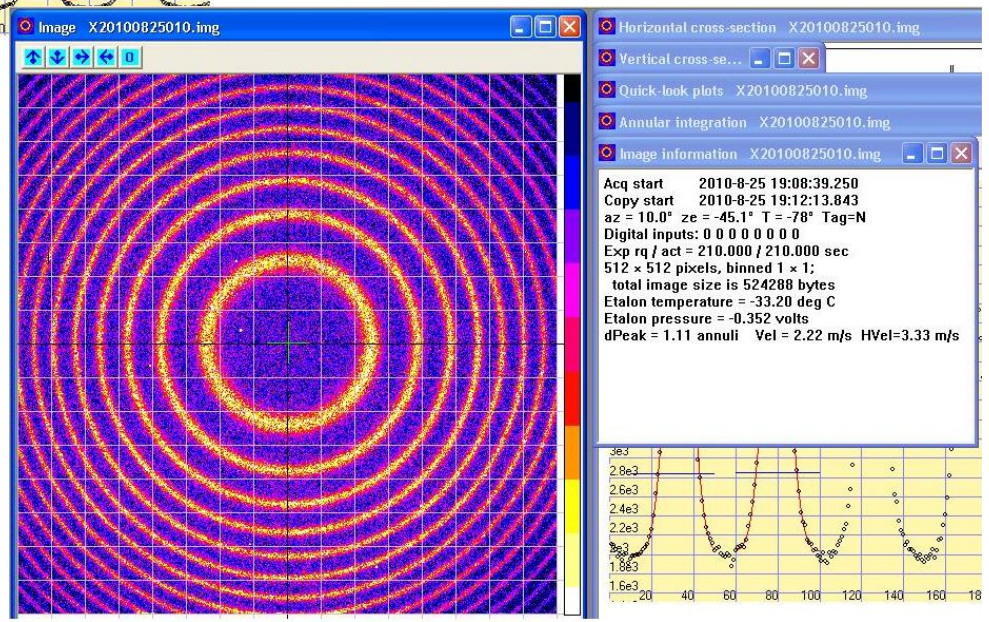
- Sky Scanner and acrilic cover
- Fabry Perot Etalon 75mm
- Filter: 630nm
- Laser Melles-Griot for calibration
- CCD Camera Andor DU-412, 512x512,
- PC: control and acquisition

FPI-MRH 630nm IMAGES



Sky interferogram at 630nm

Aug 25, 2010

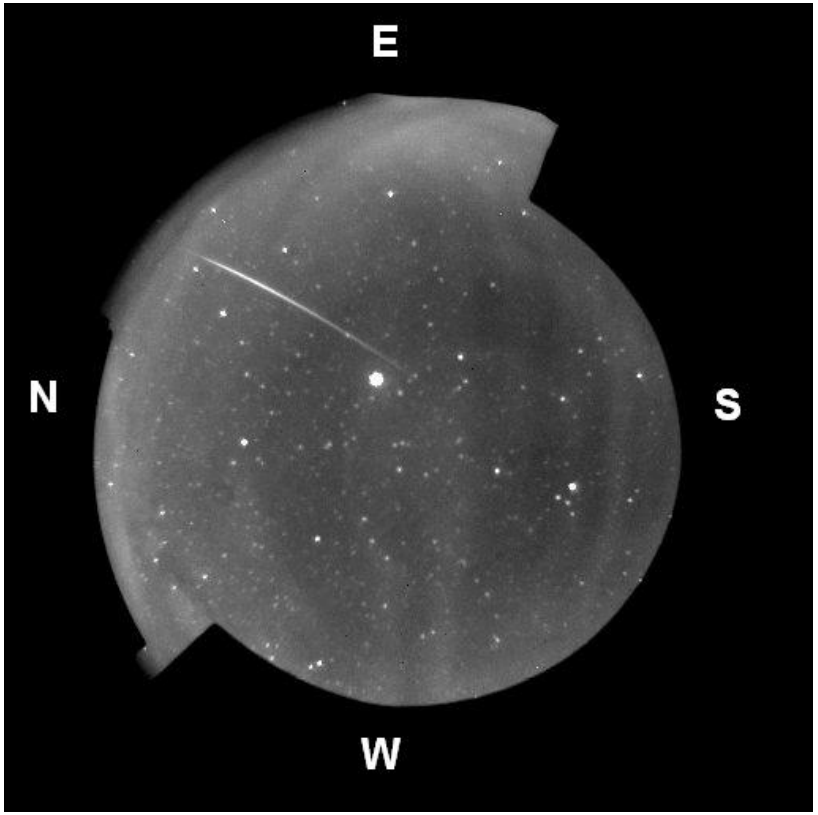


Laser Interferogram

(Instrument reference)

All-sky imaging system

External view of all-sky imager



All-sky Image with OH filter (Aug 13-14, 2010)

Portable FPI System

FPI - Paracas

Location : -13.8, -76.24 Alt : 100msnm

Installed at Fundo Santa Marta, Pisco, Icas

Oct 06-Oct 10.

External View of the FPI trailer

Internal view of Protable FPI

Solar Physics

- Collaboration with Faculty of Sciences of Ica National University
- Sun Spot observations
- Solar Flare observations
- Solar Spectroscopy

Radio Astronomy

Before

After: Nov. 19th 2010

Radio telescope of 32m is moving manually!