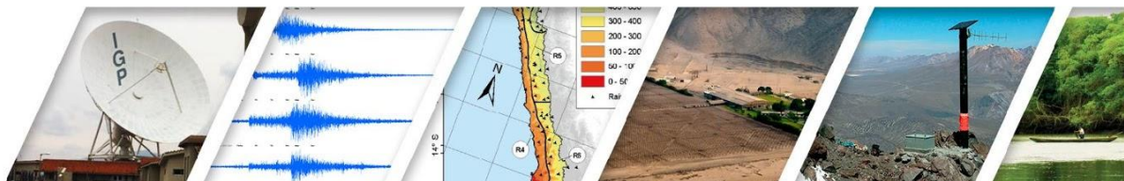
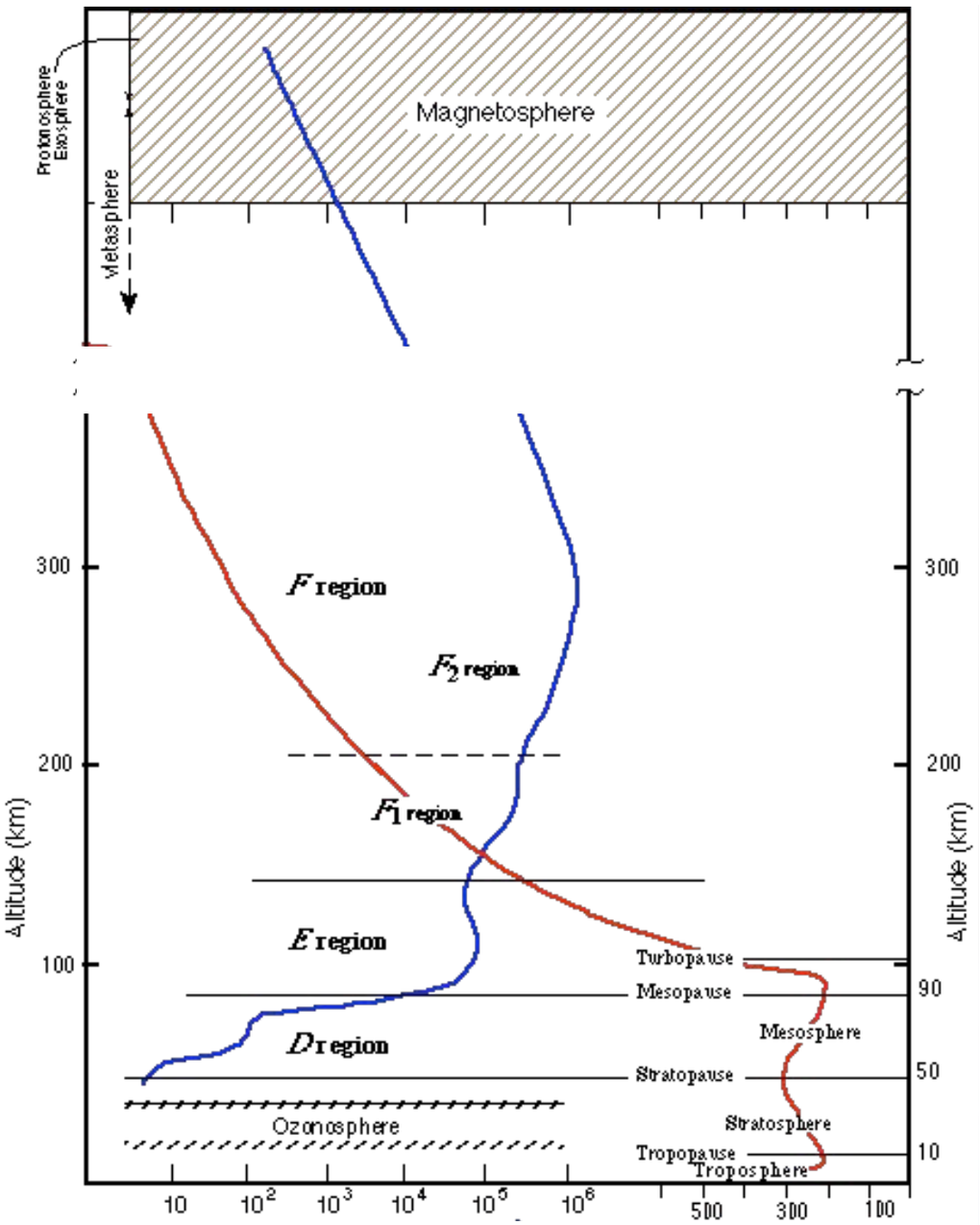
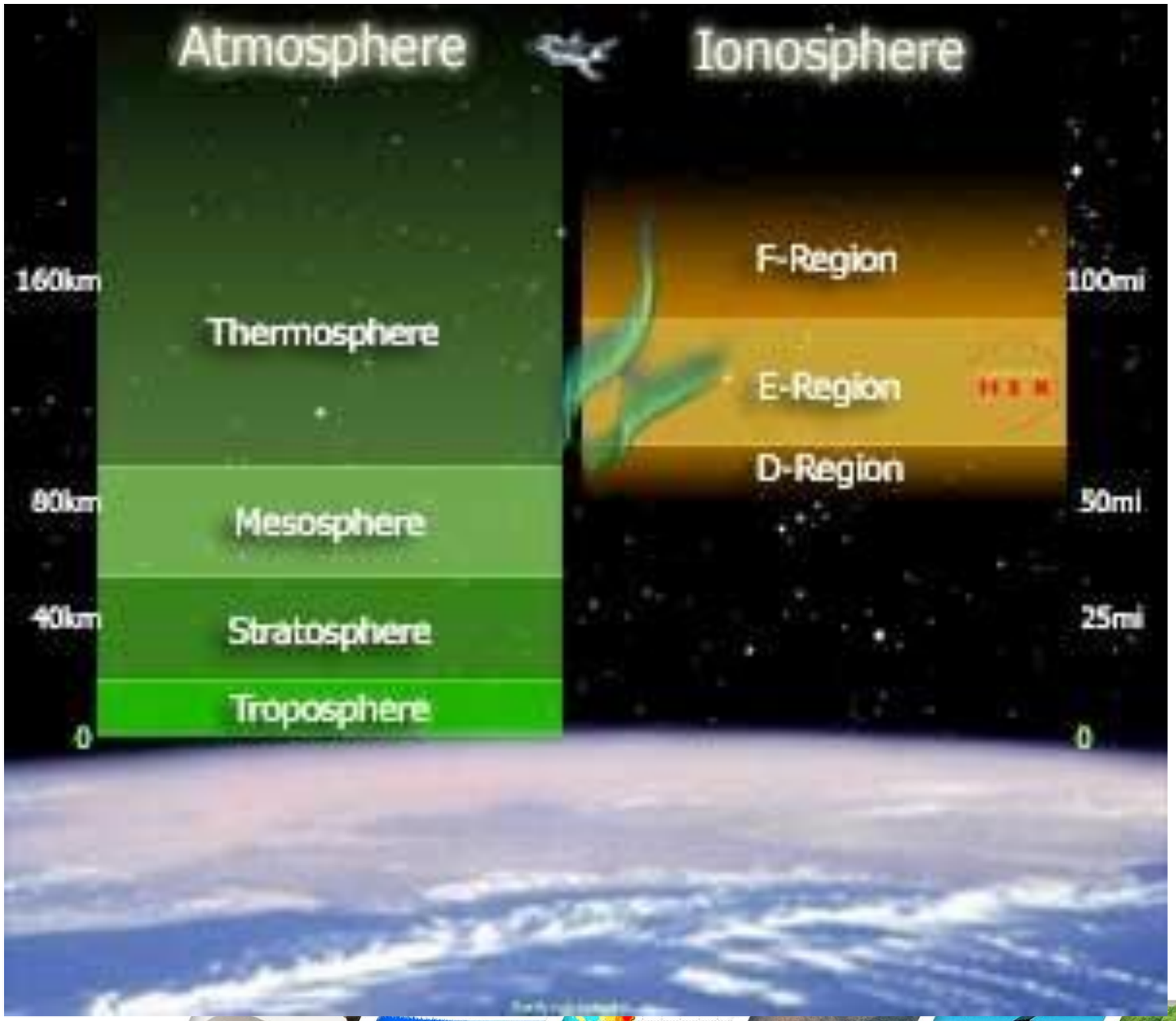
JRO Radar Operations

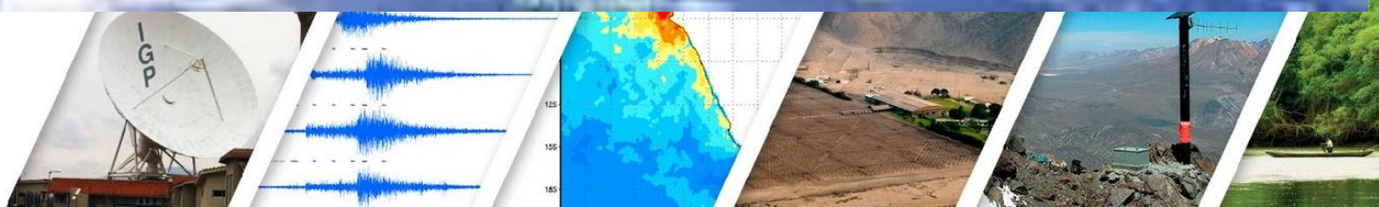
June 2019



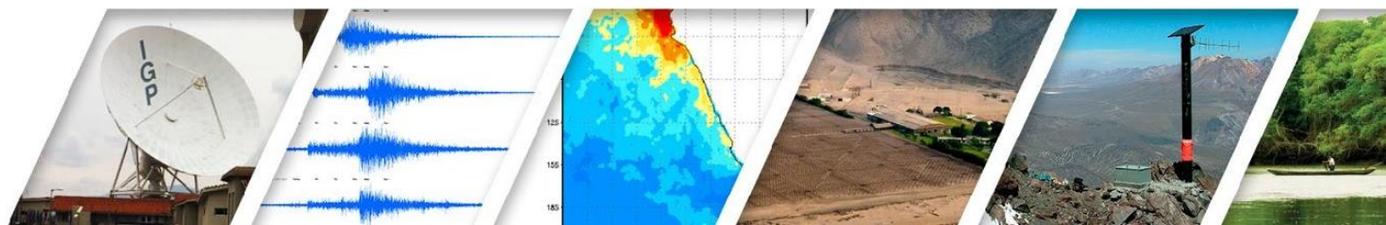
Region to study



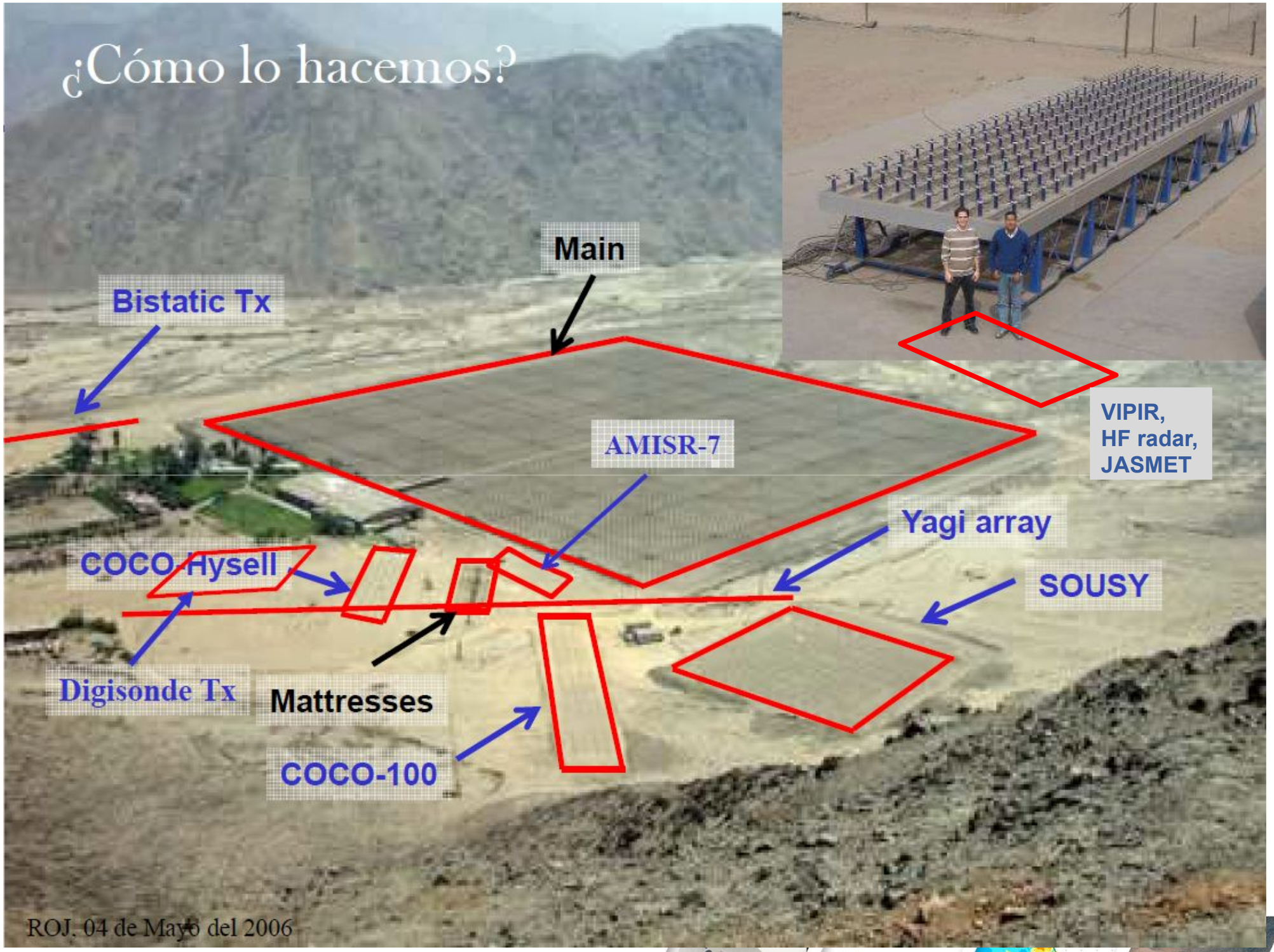


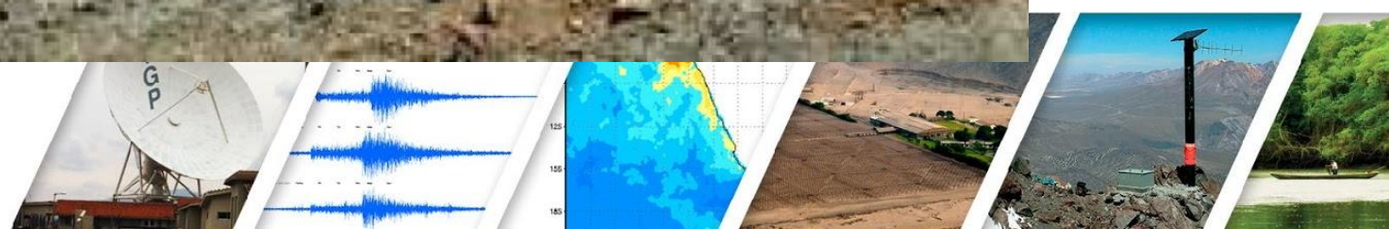


Radar block diagram



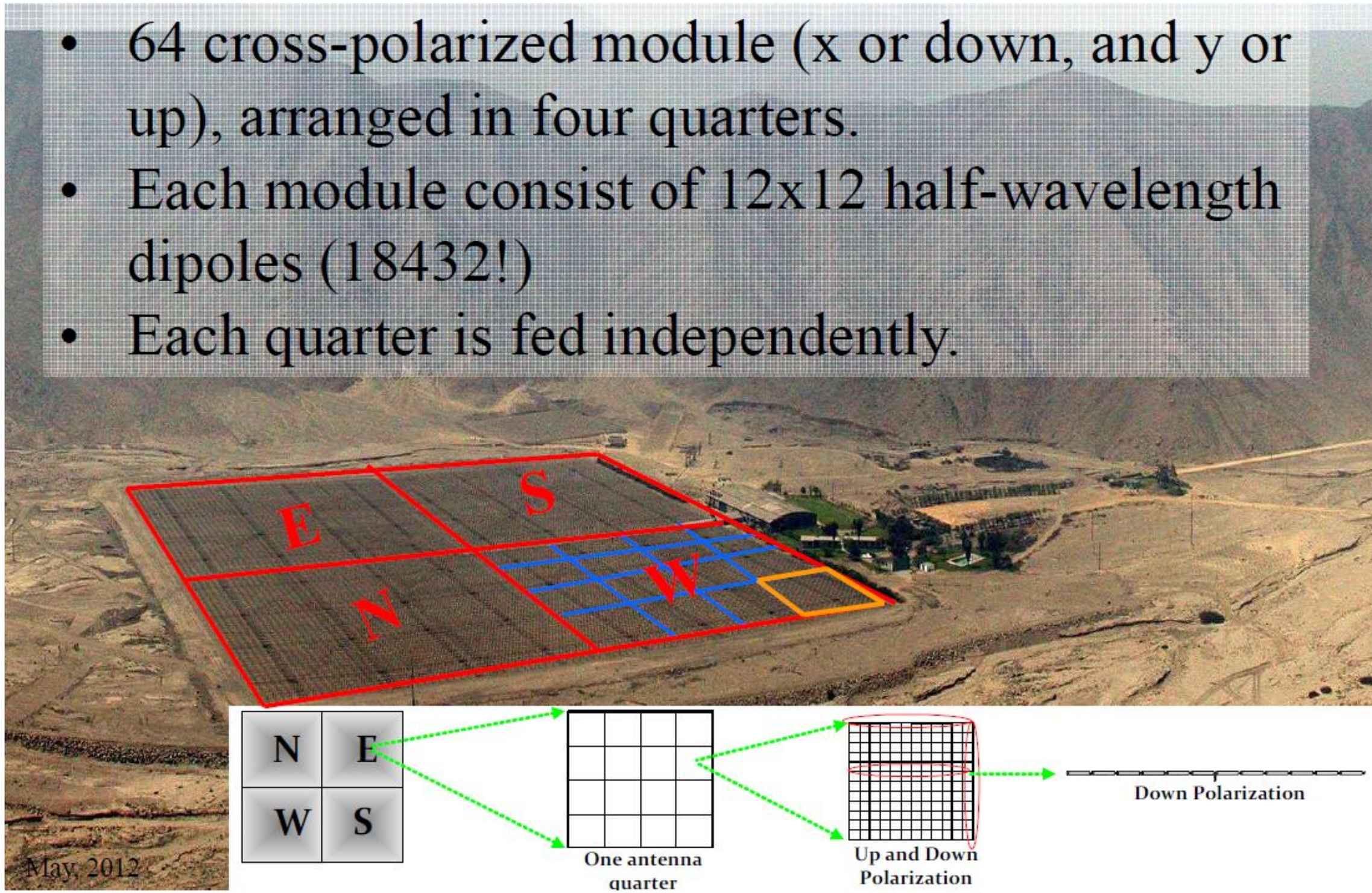
Antenna

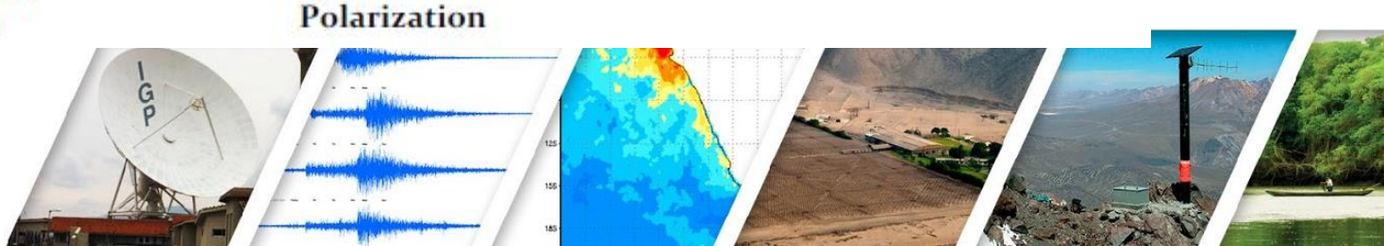

¿Cómo lo hacemos?
Main
Bistatic Tx
AMISR-7
VIPIR,
HF radar,
JASMET
Yagi array
SOUSY
COCO Hysell
Digisonde Tx
Mattresses
COCO-100
ROJ. 04 de Mayo del 2006



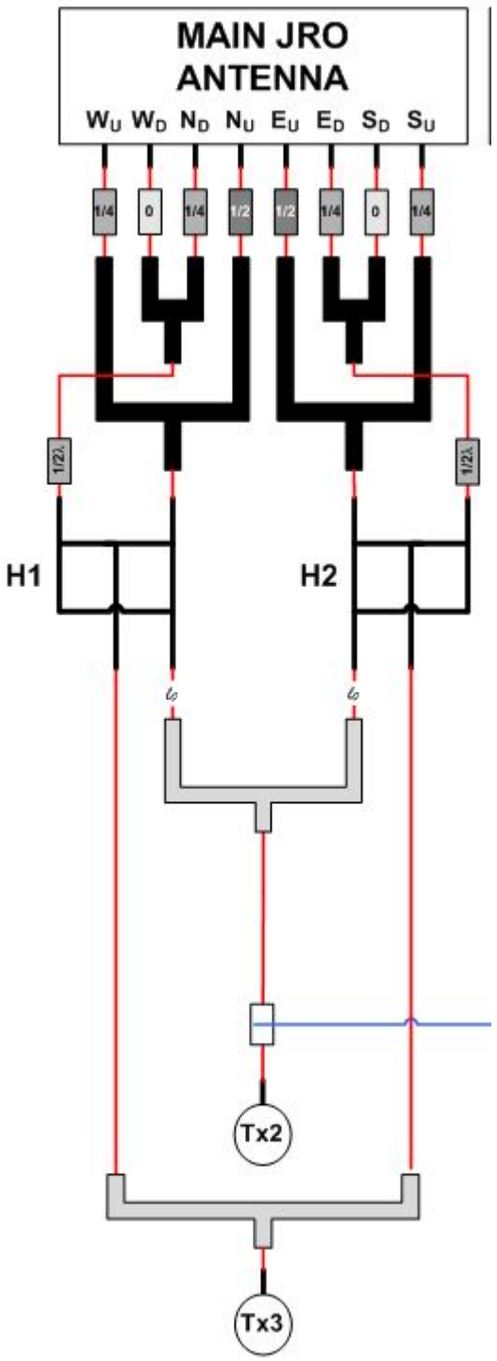
Antenna

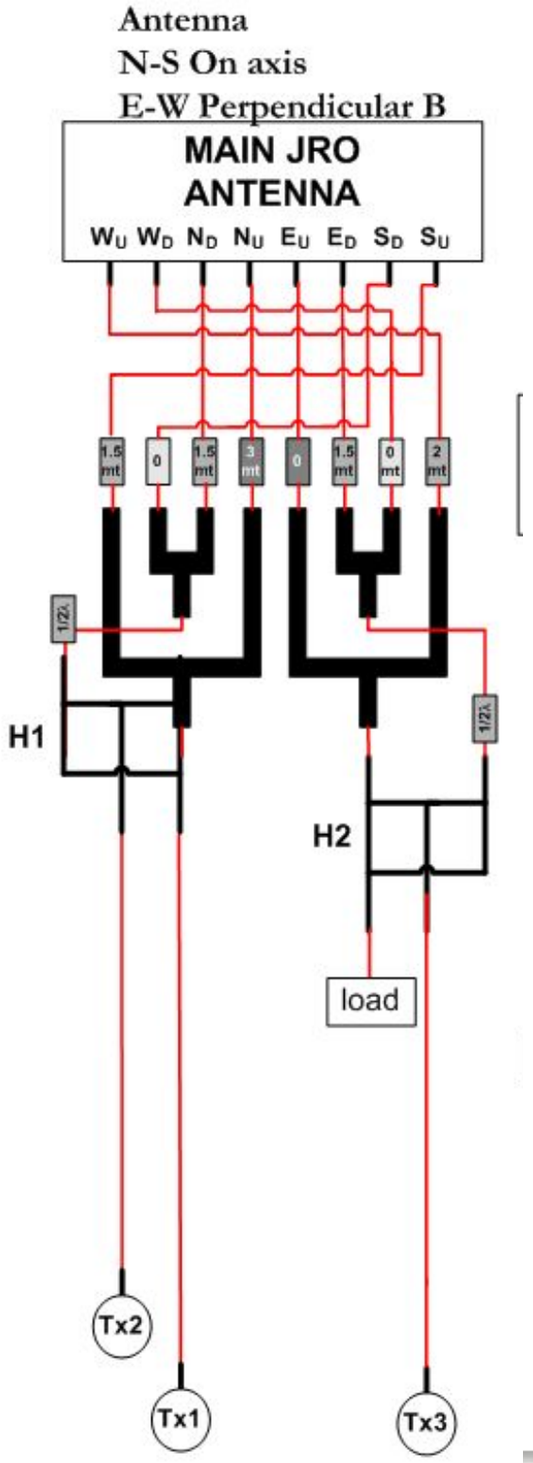
- 64 cross-polarized module (x or down, and y or up), arranged in four quarters.
- Each module consist of 12x12 half-wavelength dipoles (18432!)
- Each quarter is fed independently.

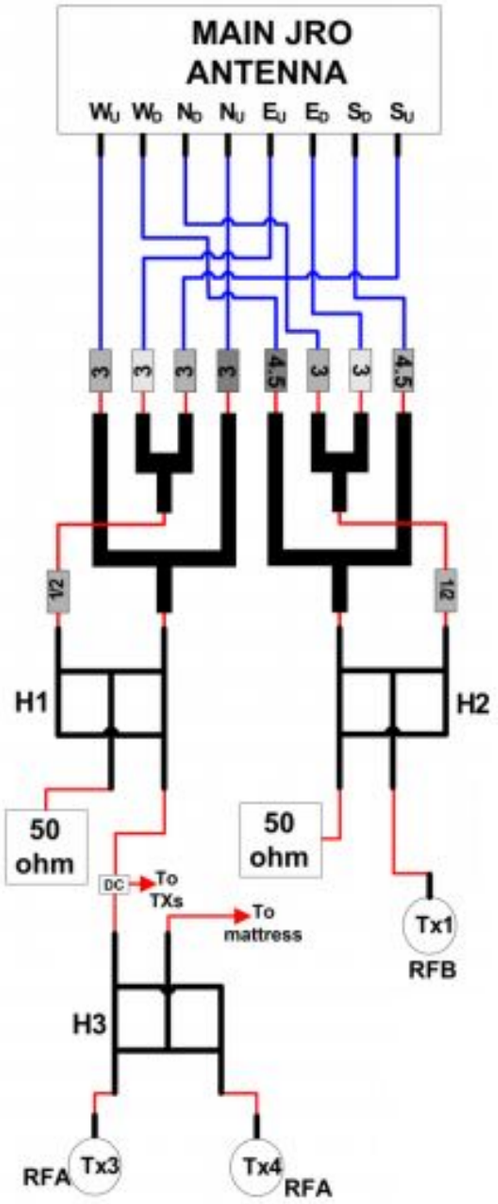


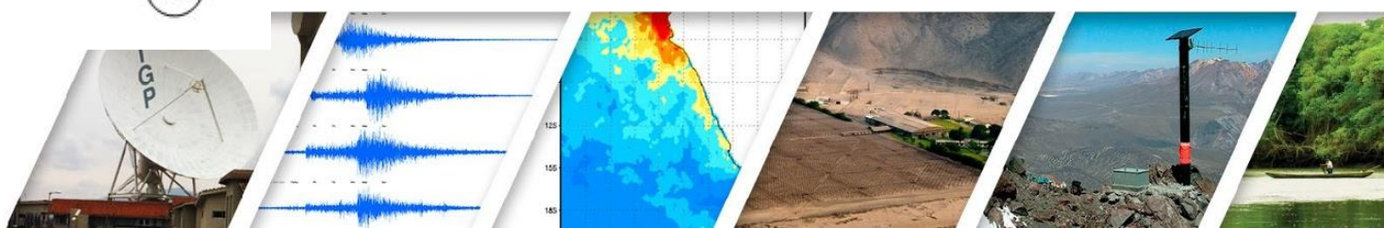


Switchyard - TX

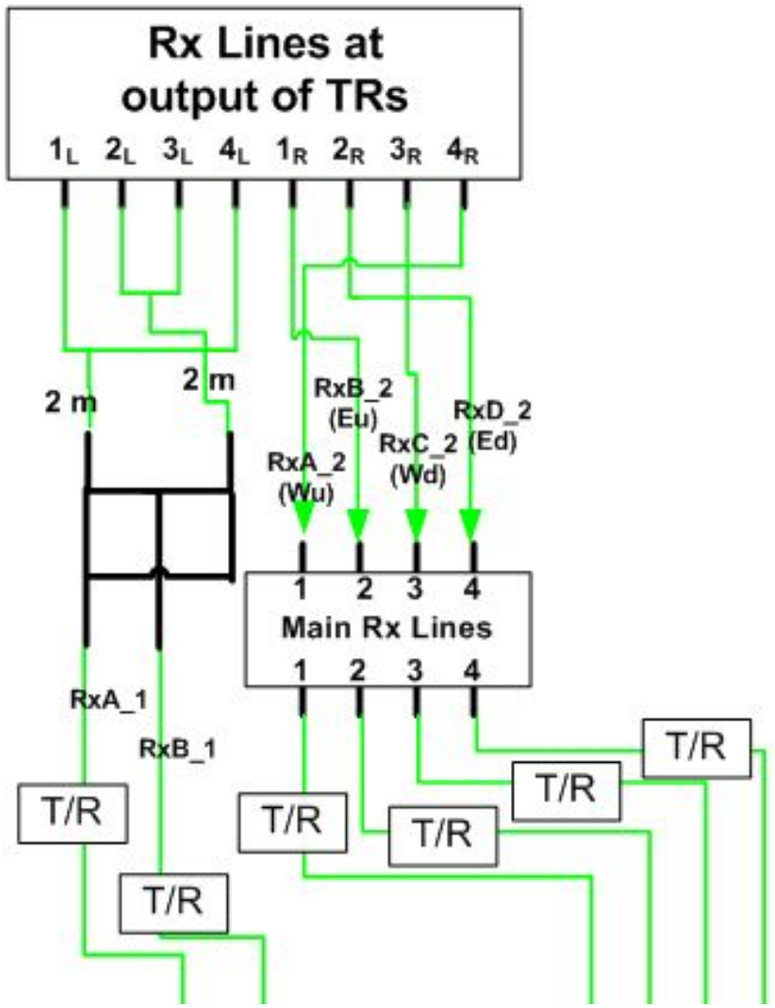


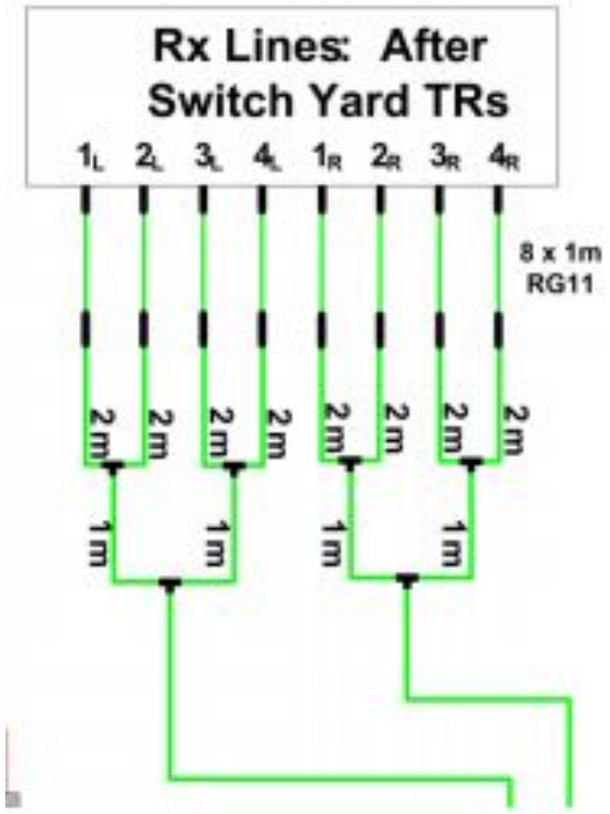


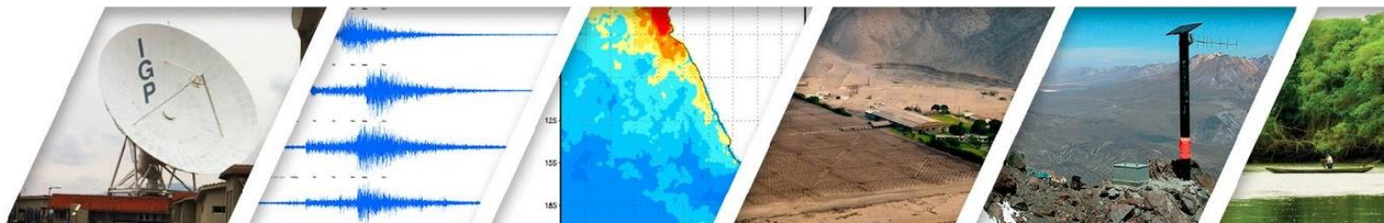




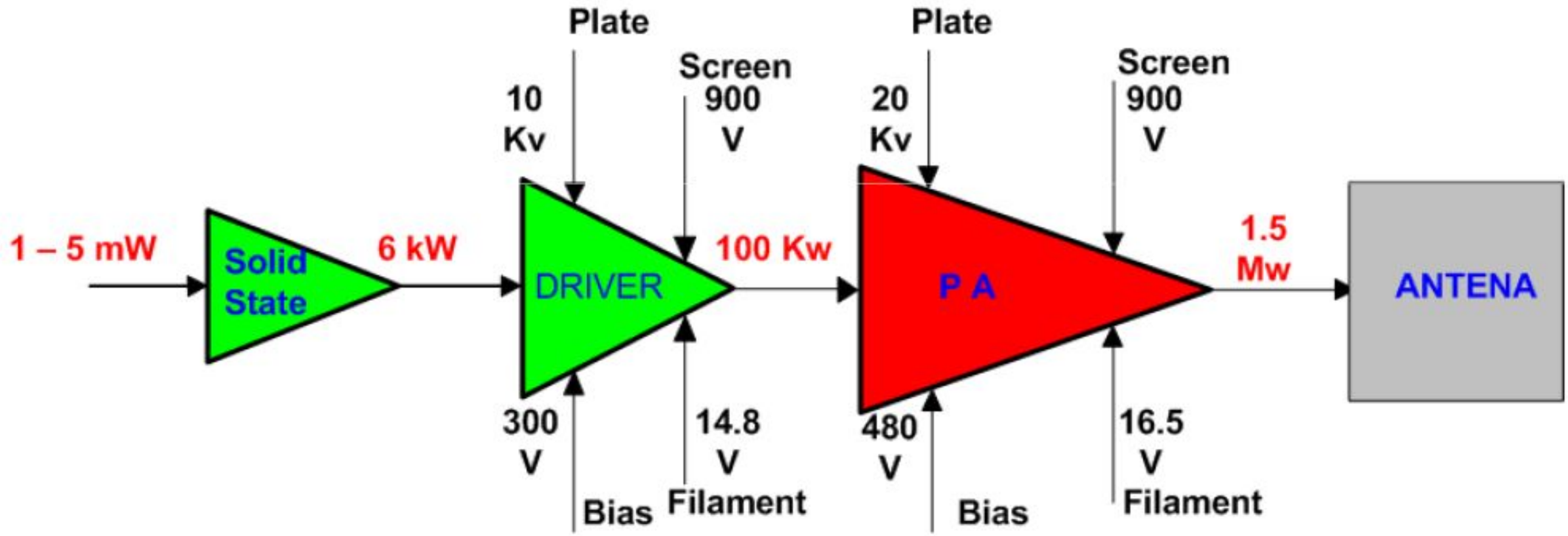
Switchyard - Rx

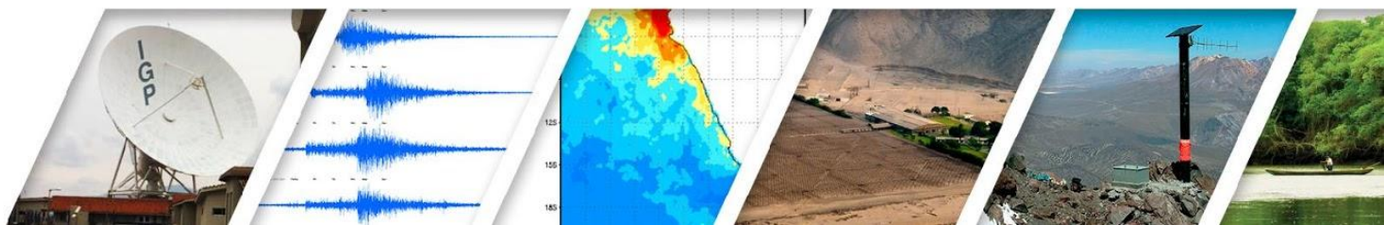




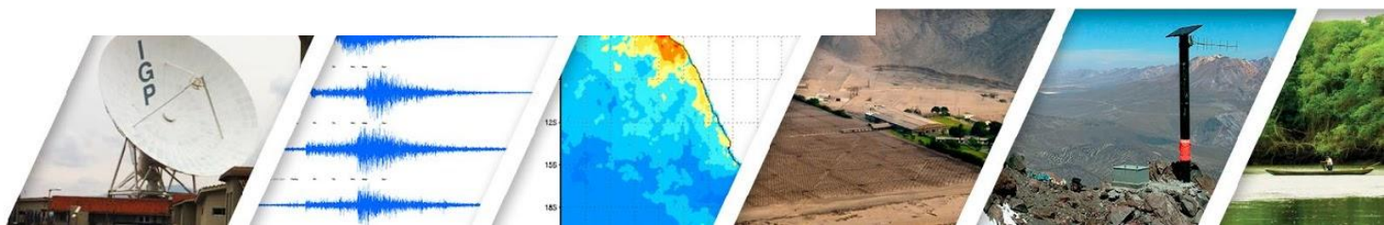


Transmitters

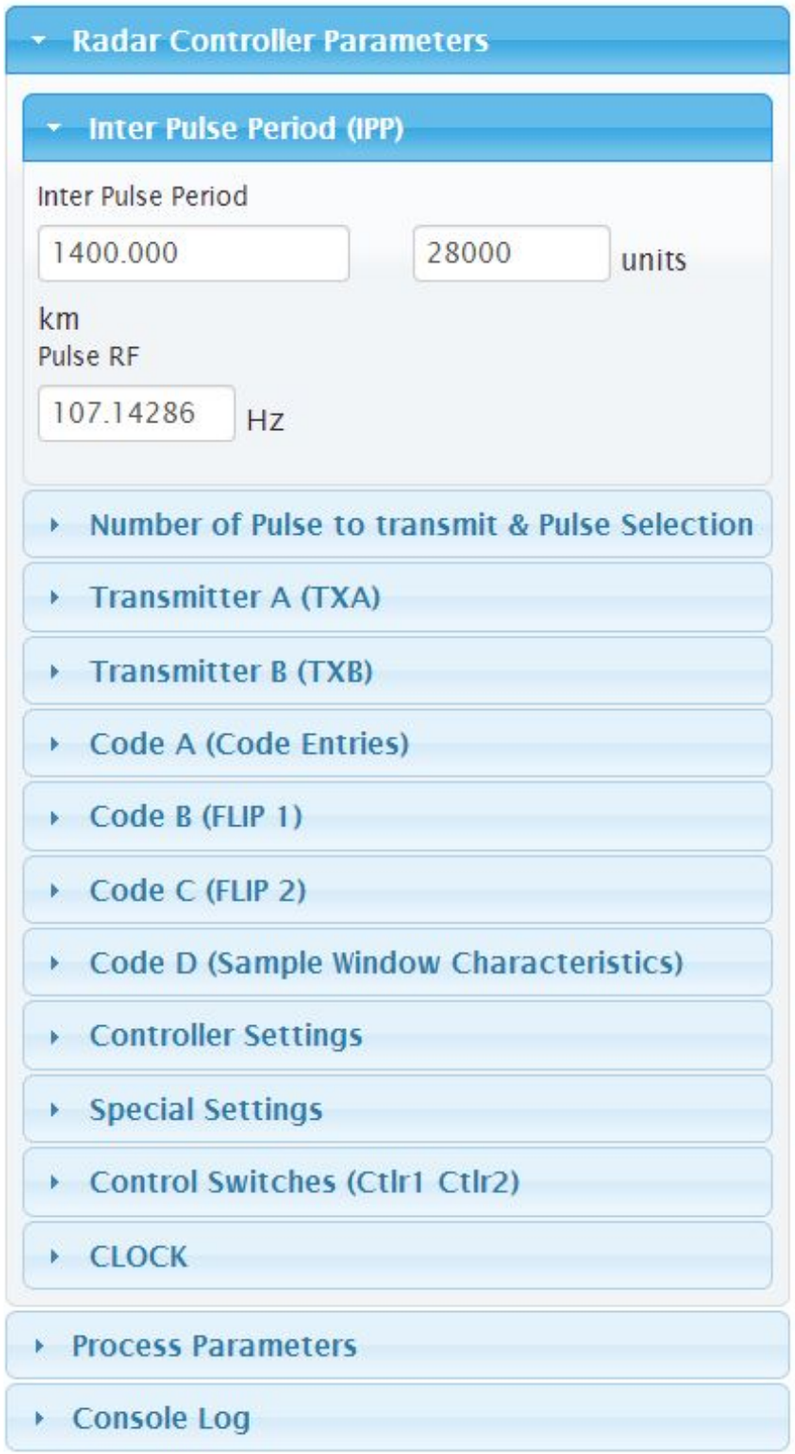


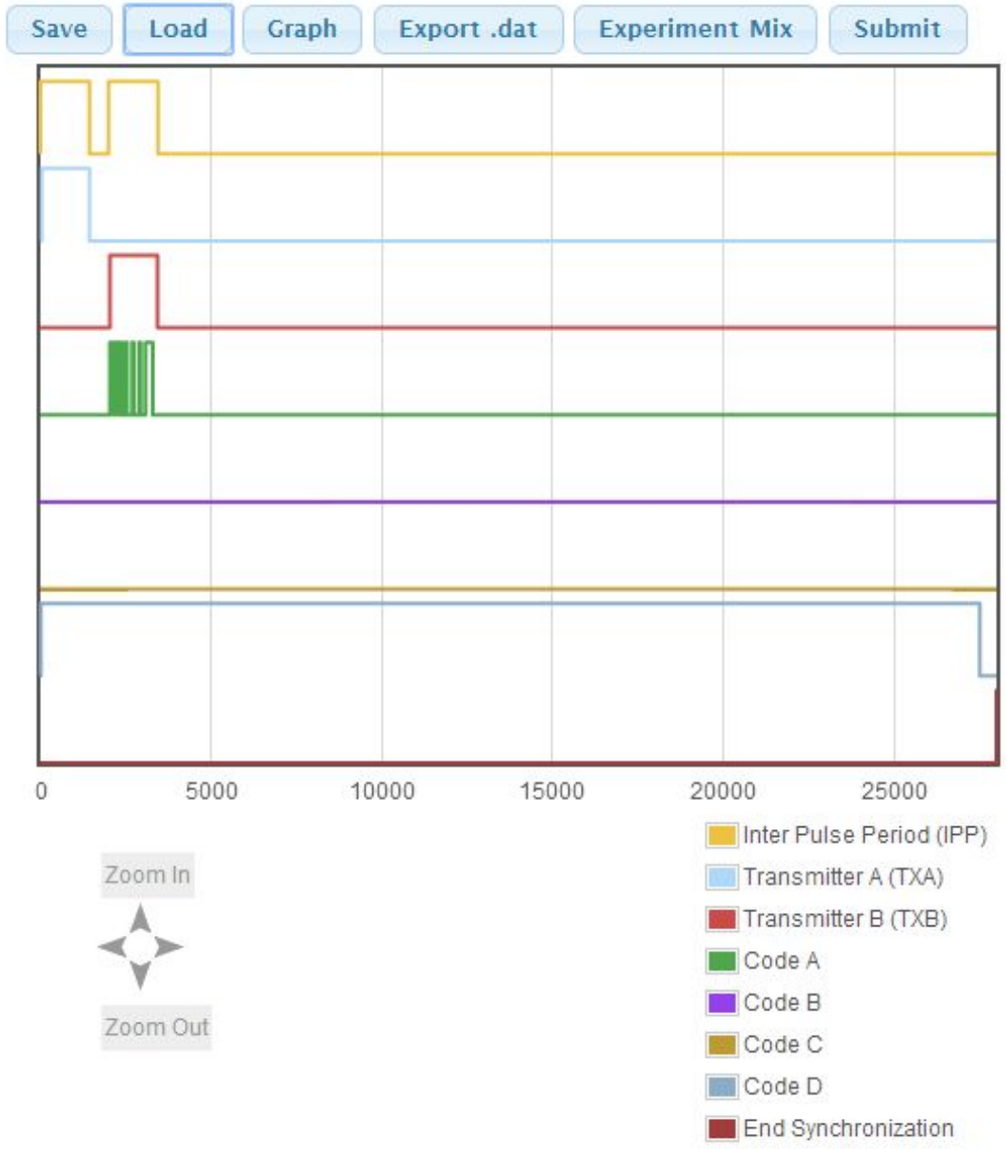


Receivers

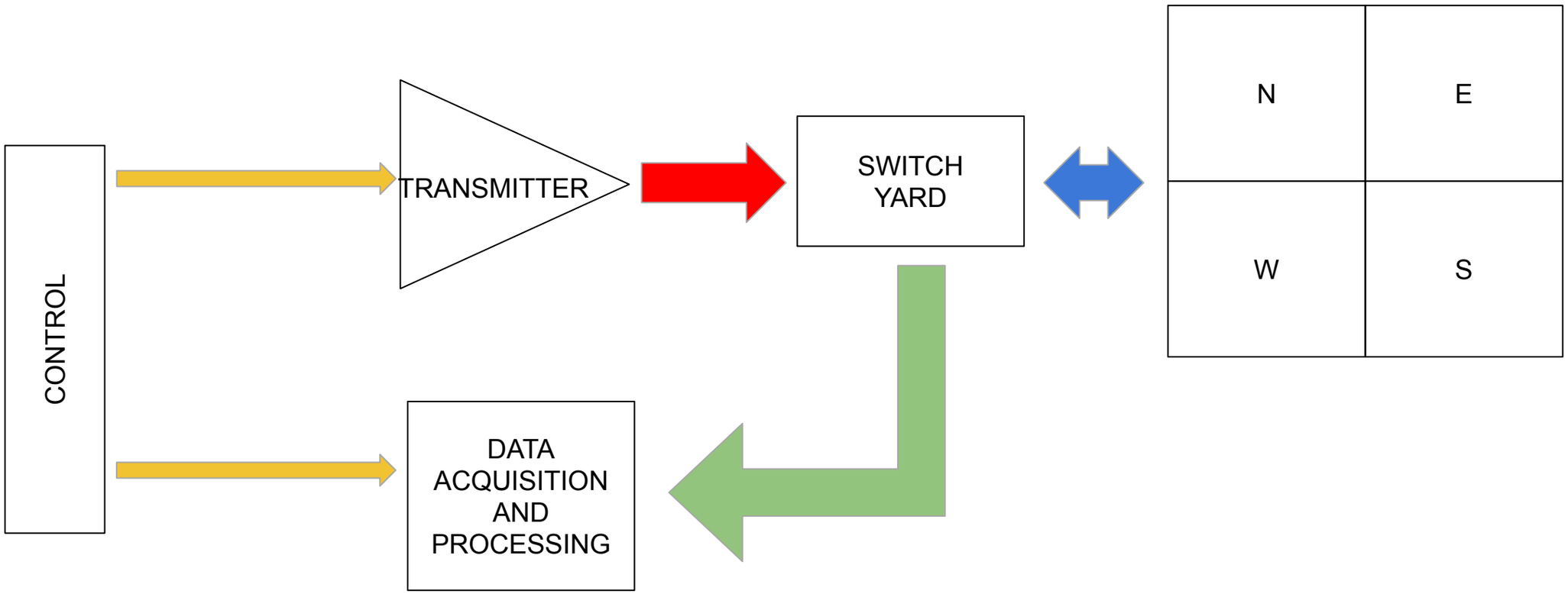


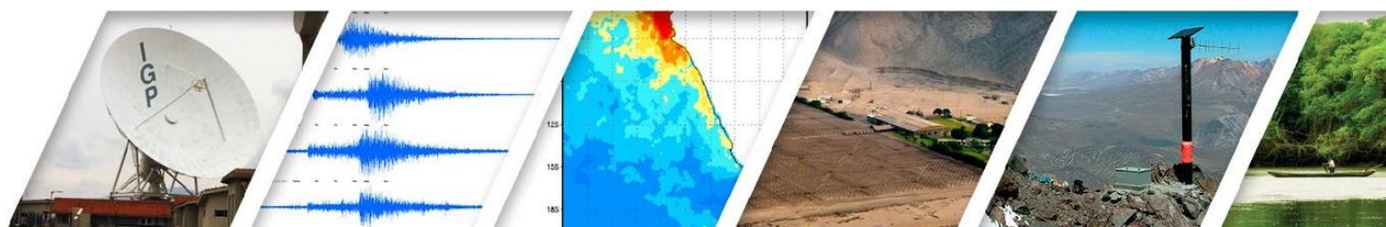
Radar Controller



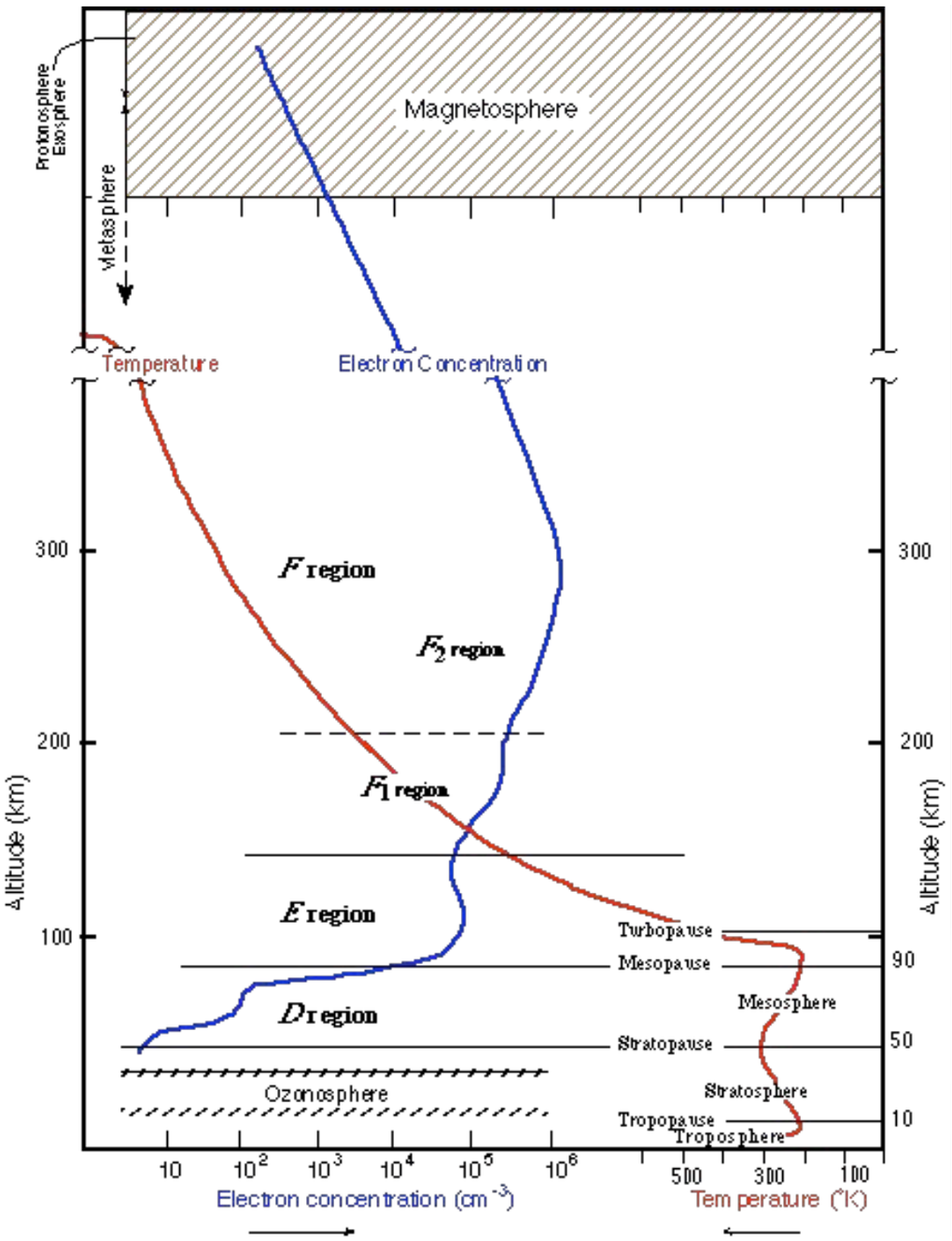


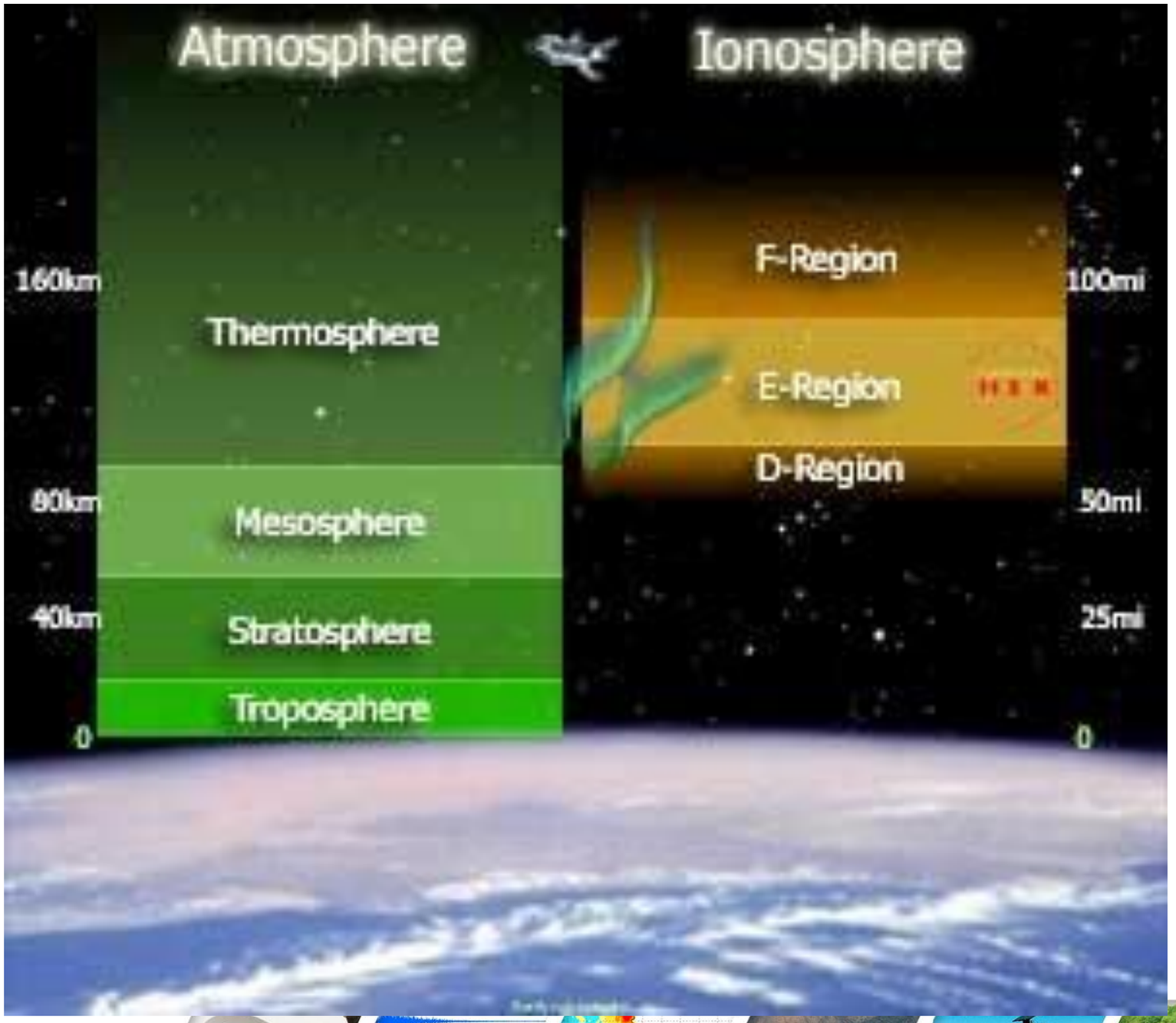
Radar block diagram

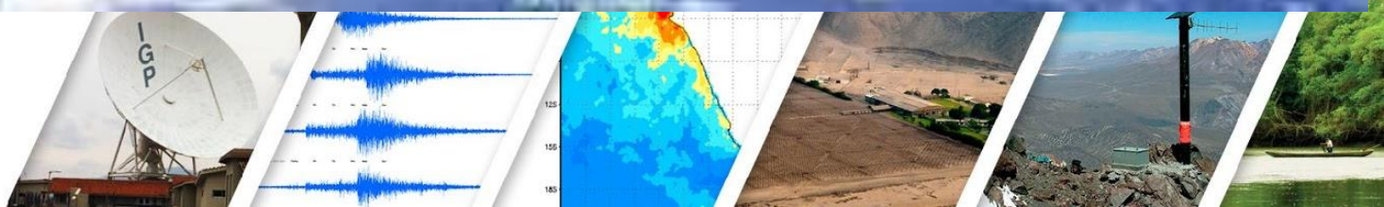




Region to study







Modos de observación en el espacio cercano con el Radar de Jicamarca

K. Kuyeng, O. Castillo, L. Condori, J. Chau

Radio Observatorio de Jicamarca, Peru

Radio Observatorio de JICAMARCA Radio Observatory

Introducción

El Radio Observatorio de Jicamarca (ROJ) es la principal estación ecuatorial de la cadena de radio observatorios de dispersión incoherente (cuyas siglas en inglés es ISR) del hemisferio oeste que se extienden desde Lima - Perú hasta Søndre Strømfjord, Groelandia y la más importante en el mundo para estudiar la ionósfera ecuatorial. Esta compuesto de tres transmisores de 1.5 MW y un arreglo de antenas de 18,432 dipolos, cubriendo un área aproximada de 85,000 m² . El estudio de la ionósfera ecuatorial ha adquirido mayor importancia debido, en gran parte, a las contribuciones hechas por el Radio Observatorio de Jicamarca.

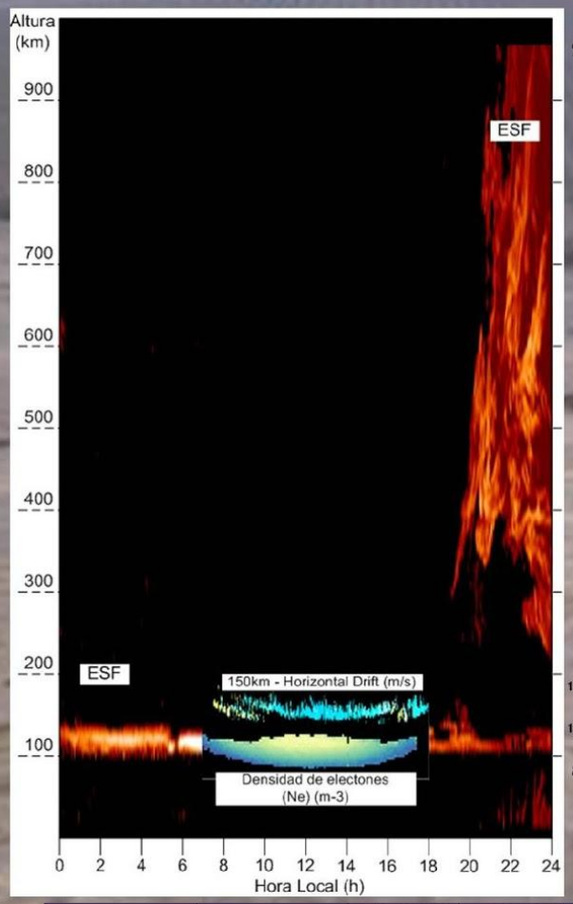
El Observatorio se ubica a media hora de viaje en automóvil hacía el este de Lima y a 10 kms de la Carretera Central (latitud 11.95° Sur, longitud 76.87° Oeste).

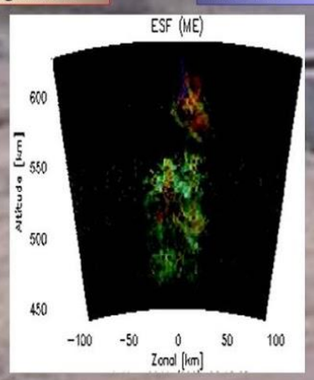
El ángulo de inclinación magnética es aproximadamente 1° y varía ligeramente con la altitud y el año. El radar puede determinar con gran precisión la dirección del campo magnético terrestre y puede ser direccionado perpendicularmente a **B** a altitudes a lo largo de la ionósfera. La altitud del ROJ es aproximadamente 500 msnm.

Los principales modos de operación del radar de Jicamarca (50-MHz) pueden ser clasificados en modos de dispersión incoherente (observaciones ionosféricas) y dispersión coherente.(observaciones de irregularidades ionosféricas y atmosféricas).

El siguiente es un resumen de los diferentes modos y las mediciones que se obtienen a través de los mismos.

Dispersión Coherente

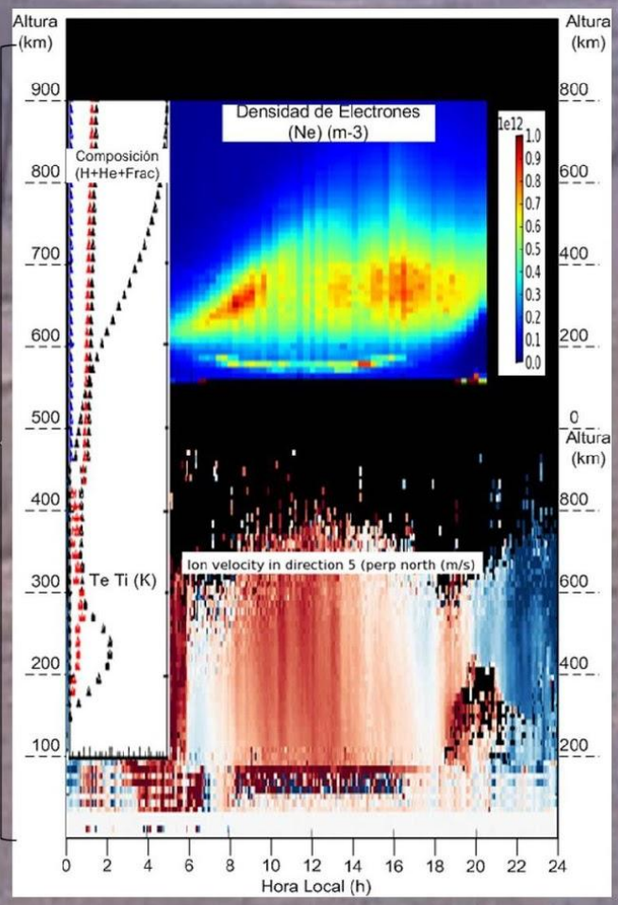




PARÁMETROS MEDIDOS	MODO DE OPERACIÓN
-Drifts ESF	JULIA EW -ESF
-Imágenes ESF	IMÁGENES
-Drifts 150km	JULIA EW -150km
-Imágenes 150km	IMÁGENES
-Densidad de electrones	RADAR BIESTÁTICO
-Imágenes EEJ	IMÁGENES
-Meteoros (Head echoes)	METEOROS
-Vientos Zonal y Meridional	JASMET (80 – 100km)
-Drifts mesósfera	MST-ISR

EXPERIMENTOS		PARÁMETROS MEDIDOS		RANGO MEDIDO (km)		RESOLUCIÓN (ALTURA, TIEMPO)		ANTENA	TRANSMISORES (POTENCIA)		Ciclo de trabajo (%)	
JASMET		Drifts Zonal y Meridional				5km,1 hora		Arreglo de yagis (1tx, 5 rx)	TOMCO (20kW)		1.8%	
METEOROS		Caraterísticas de los meteoros		80-120		150m,		Antena principal-polarización Up (ON-AXIS)	2 transmisores (pot=1MWc/u)		3% (BARKER13)	
JULIA EW	150km	Drifts 150km		130-180		3km , 5min		Antena principal	3 MST (20kW c/u)		0.8%	
	EEJ (Yagi)			80-100		1.5km		Arreglo de Yagi Oblicuas	1 TOMCO (12kW)		0.4%	
	ESF	Drift ESF		0-937.5		3.75km, 255eg		Antena principal	1 MST (20kW)		0.4%	
IMAGENES		EEJ	150km	80-120	130-180	150m	300m	8 módulos de la antena principal2	MST	2Tx (1MW)	0.2%	4%
		ESF		0-937.5		1.5km			2 ATRAD (16kW)		8.96%	
RADAR BIESTATICO		Densidad de electrones		80-120		600m, 5min		Arreglo de Yagis (Jicamarca y Paracas)	TOMCO (12kW)		2.08%	
MST-ISR 2 (MST)		Drift mesósfera		10-180		150m		Toda la antena principal	2 transmisores (pot=1MWc/u)		4.84%	

Dispersión Incoherente



MODO DE OPERACIÓN	PARÁMETROS MEDIDOS
DVD	-Drifts Vertical
DEWD	-Drifts Zonal
MST-ISR 2	
DVD	-Densidad de electrones (absoluta)
HYBRID2	-Densidad de electrones (relativa)
MST-ISR 2	
HYBRID2	-Ti
	-Te
HYBRID2	-Te/Ti
MST-ISR 2	
HYBRID2	-Composición (H+,He+)

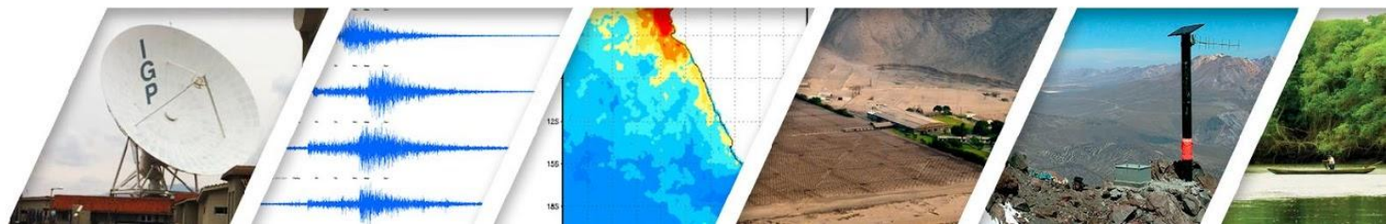
EXPERIMENTOS	PARÁMETROS MEDIDOS		RANGO MEDIDO (km)	RESOLUCIÓN (ALTURA, TIEMPO)	ANTENA	TRANSMISORES (POTENCIA)	Ciclo de trabajo (%)
HYBRID2 (Fulso Largo-LP y Doble pulso Faraday-DP)	Densidad de electrones	Te	LP: 0-3000 DP: 0-1005	3.75km, 15min	Toda la antena principal	2(3) transmisores (pot=1MWc/u)	3.84%
	Ti	Composición					
MST-ISR 2 (ISR)	Drift Vertical	Drift Zonal	75-1000	7.5km,	Toda la antena principal	2 transmisores (pot=1MWc/u)	4.84%
	Densidad de electrones	Te/Ti					
DEWD	Drift vertical	Drifts Zonal	0-930	3.75km, 5min	Toda la antena principal	2 transmisores (pot=1MWc/u)	3.84%
DVD	Drift Vertical	Densidad de electrones	100-1000	5km, 5min	Toda la antena principal	2(3) transmisores (pot=1MWc/u)	4%

Presentado en ECI (Encuentro Científico Internacional) , Lima-Perú, Enero 2010

Considerations for experiment configuration

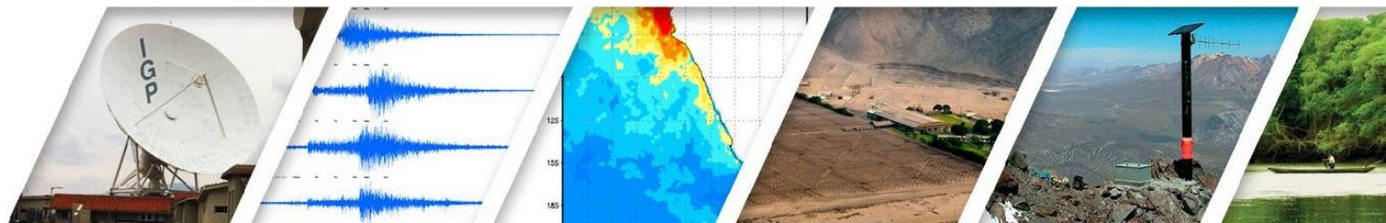
BASIC CONFIGURATIONS

- Antenna pattern beam
- Transmission power
- IPP (InterPulsePeriod)
- TRANSMISSION PULSE
- SAMPLING WINDOW
- SAMPLING RATE



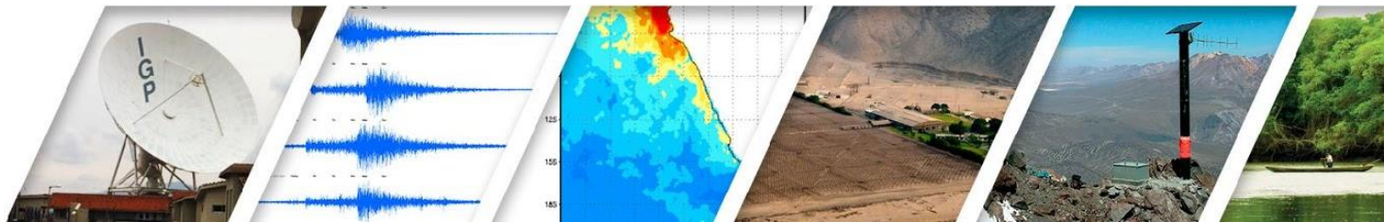
INSTITUTO GEOFÍSICO DEL PERÚ

INCOHERENT SCATTERING ECHOES



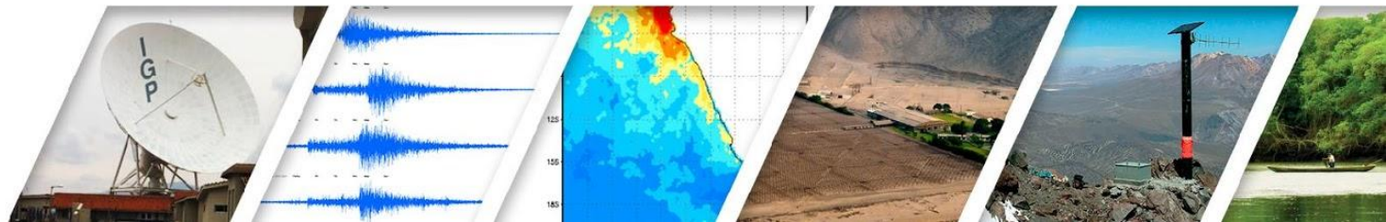
Experiments summary

EXPERIMENTS	MEASURED PARAMETERS		RANGE (km)	RESOLUTION (HEIGHT TIME)	ANTENNA	TRANSMITTERS (POWER)	Duty Cycle (%)
HYBRID2 (Long Pulse-LP and Double pulse Faraday-DP)	Electron density	Te	LP: 0-3000 DP: 0-1000	3.75km, 15min	Main Antenna (all)	2(3) Txs (pow=1MWc/u)	3.84%
	Ti	Composition					
MST-ISR 2 (ISR)	Vertical Drift	Zonal Drift	75-1000	7.5km,	Main Antenna (all)	2 Txs (pow=1MWc/u)	4.84%
	Electron Density	Te/Ti					
DEWD	Vertical Drift	Zonal Drift	0-930	3.75km, 5min	Main Antenna (all)	2 Txs (pow=1MWc/u)	3.84%
DVD	Vertical Drift	Electron Density	100-1000	5km, 5min	Main Antenna (all)	2(3) Txs (pow=1MWc/u)	4%

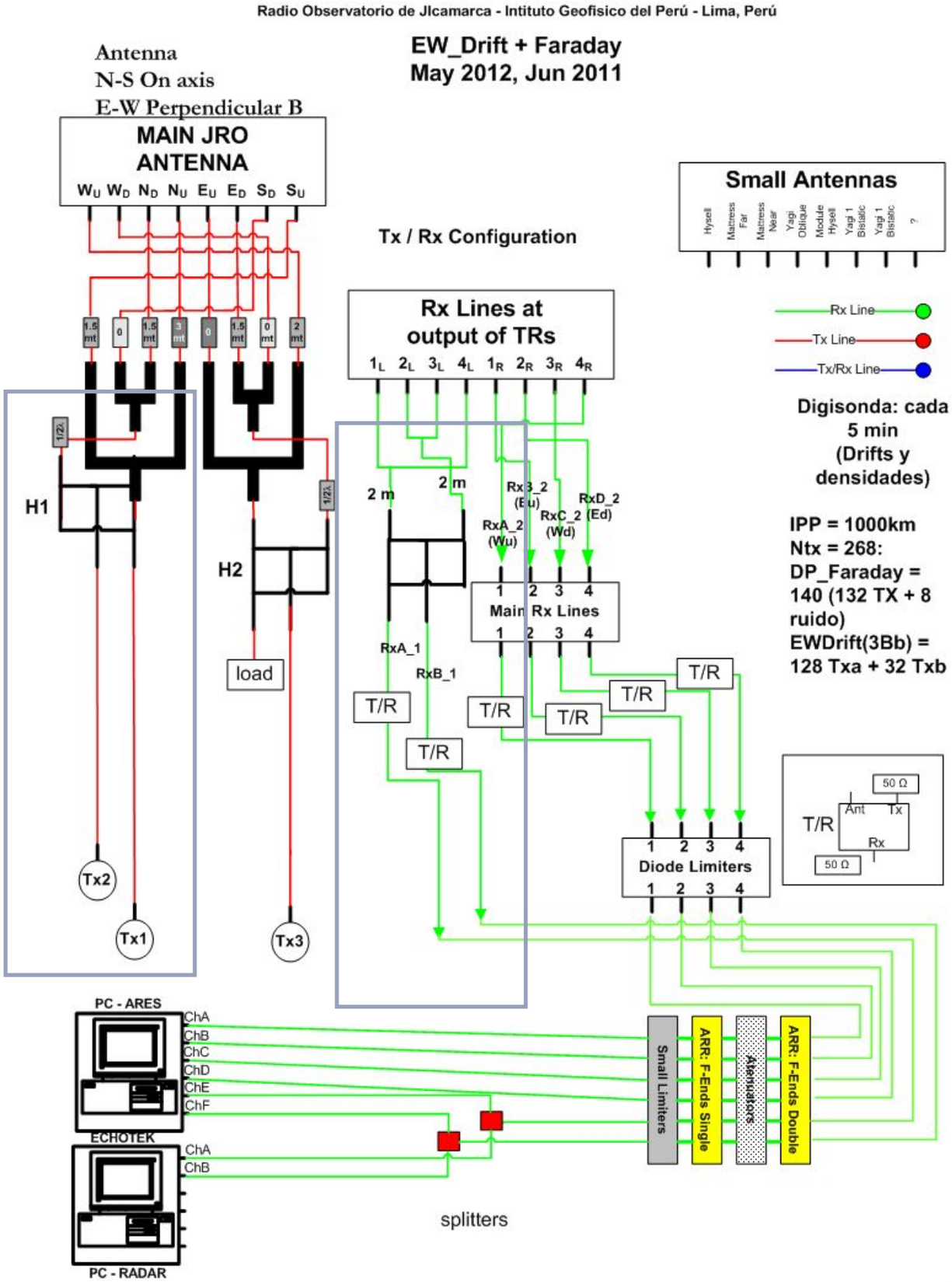


EW Drift + Faraday

Parameters / Exp Modes	EW DRIFT		FARADAY	
	EW DRIFT	EW DRIFT + FARADAY	FARADAY	EW DRIFT + FARADAY
Measured parameters	Vertical and zonal drifts	Vertical and zonal drifts	-Electron Density - Te, Ti - Composition	- Electron Density - Te, Ti
Measured range	0-1000km	0-1000km	LP: 0-3000km DP: 0-1000km	DP: 0-1000km
Res (h/t)	5km / 5min	5km / 5min	3.75km / 15min	5km / 15min
Antenna	All Antenna	1/2 Antenna (East and West)	All Antenna	1/2 Antenna (North and South)
Transmitters	2 (1Mw each)	1Mw	2 (1Mw each)	2 (1Mw each)
Duty cycle	4%	4.5% (1.92%)	3.84%	1.5% (0.74%)



- Faraday



Main Antenna Phasing

North Quarter

4/2	4/2	5/3	5/3
4/2	5/3	5/3	2/4
5/3	5/3	2/4	2/4
5/3	2/4	2/4	3/5

East Quarter

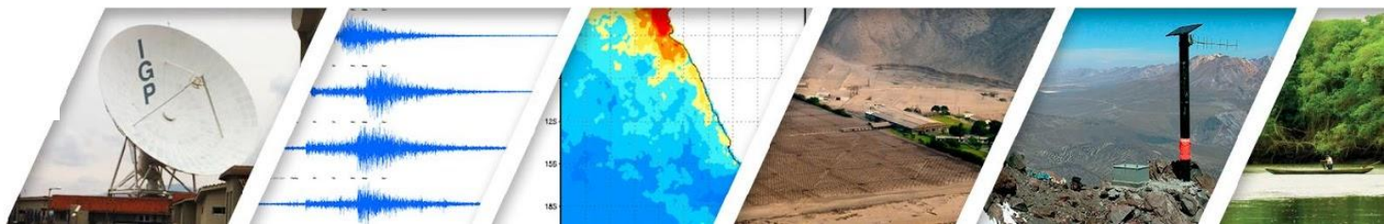
2/2	5/2	3/3	2/3
3/5	2/5	4/2	3/2
4/3	3/3	5/4	4/4
5/2	4/2	2/3	5/3

West Quarter

2/4	5/4	3/5	2/5
3/3	2/3	4/4	3/4
4/5	3/5	5/2	4/2
5/4	4/4	2/5	5/5

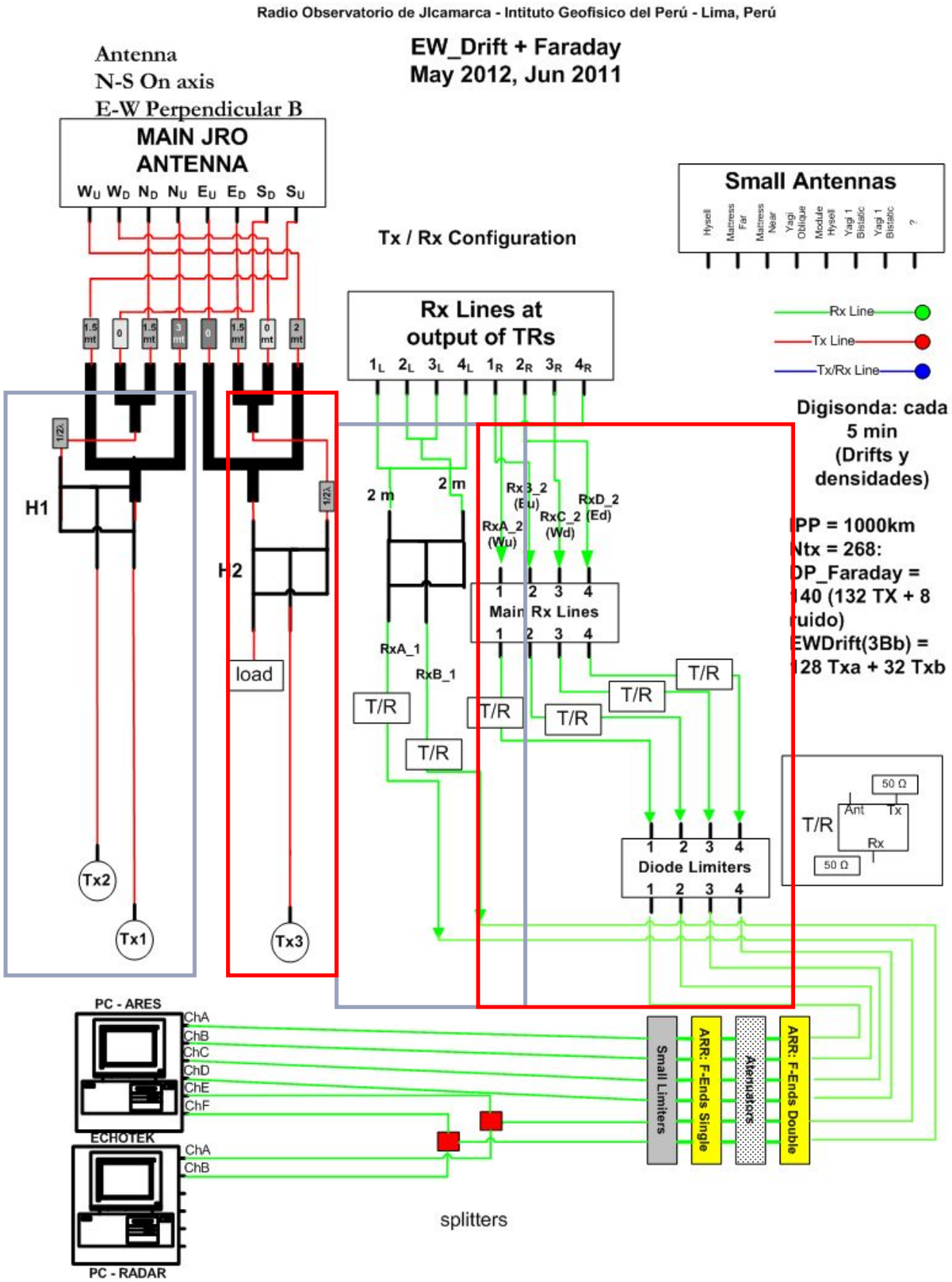
South Quarter

5/3	5/3	2/4	2/4
5/3	2/4	2/4	3/5
2/4	2/4	3/5	3/5
2/4	3/5	3/5	4/2



- Faraday

- EW Drift



Main Antenna Phasing

North Quarter

4/2	4/2	5/3	5/3
4/2	5/3	5/3	2/4
5/3	5/3	2/4	2/4
5/3	2/4	2/4	3/5

East Quarter

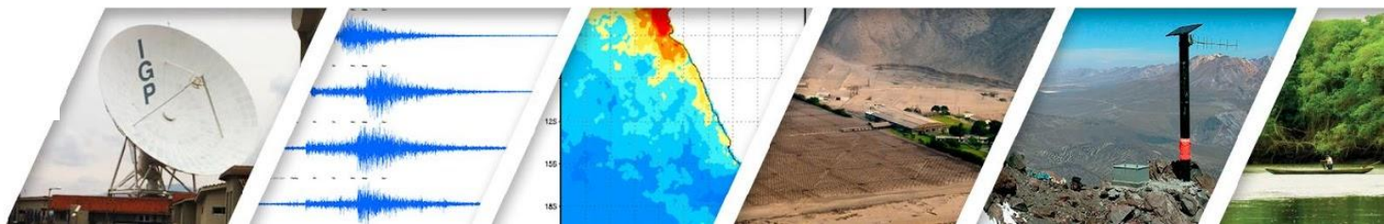
2/2	5/2	3/3	2/3
3/5	2/5	4/2	3/2
4/3	3/3	5/4	4/4
5/2	4/2	2/3	5/3

West Quarter

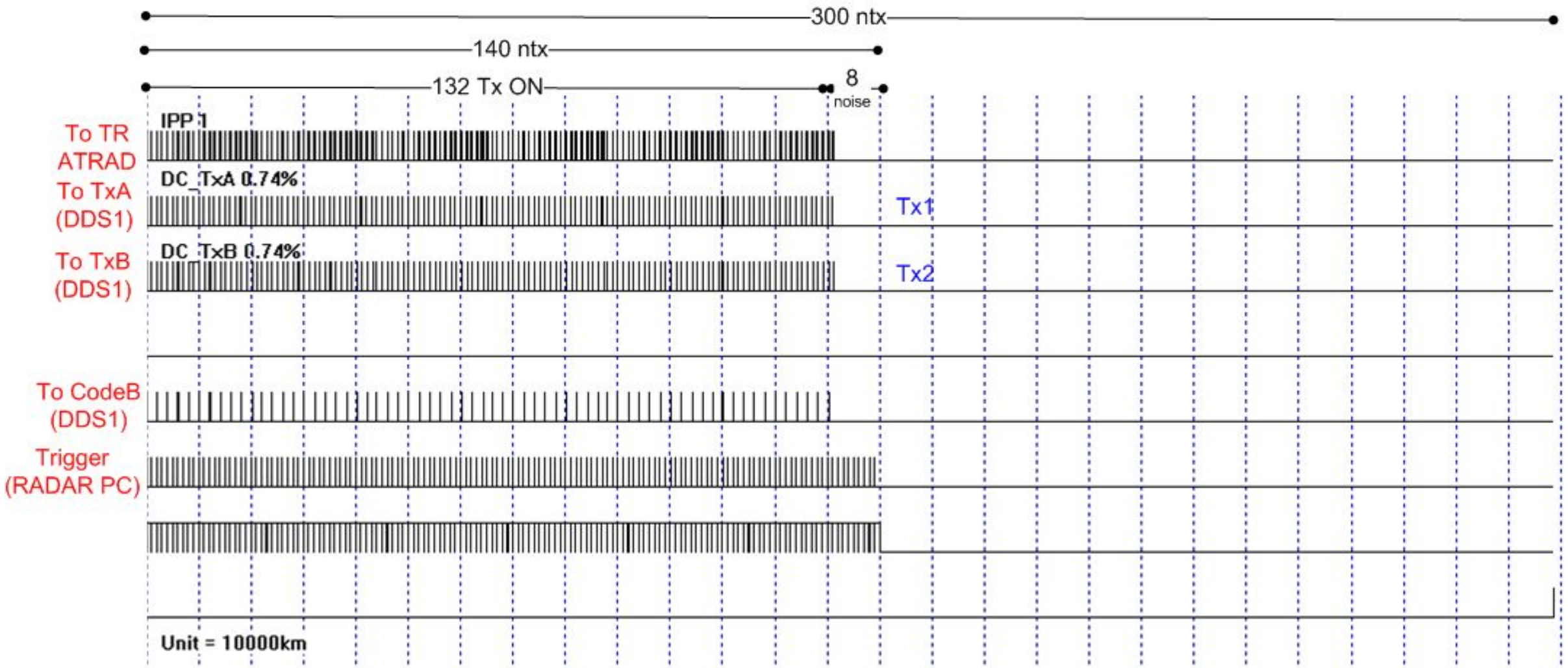
2/4	5/4	3/5	2/5
3/3	2/3	4/4	3/4
4/5	3/5	5/2	4/2
5/4	4/4	2/5	5/5

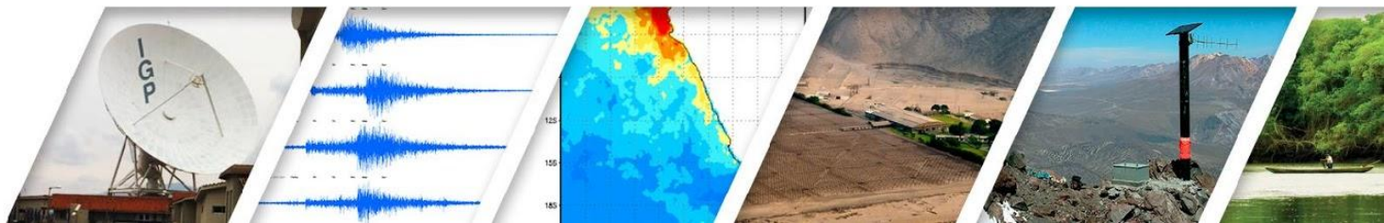
South Quarter

5/3	5/3	2/4	2/4
5/3	2/4	2/4	3/5
2/4	2/4	3/5	3/5
2/4	3/5	3/5	4/2

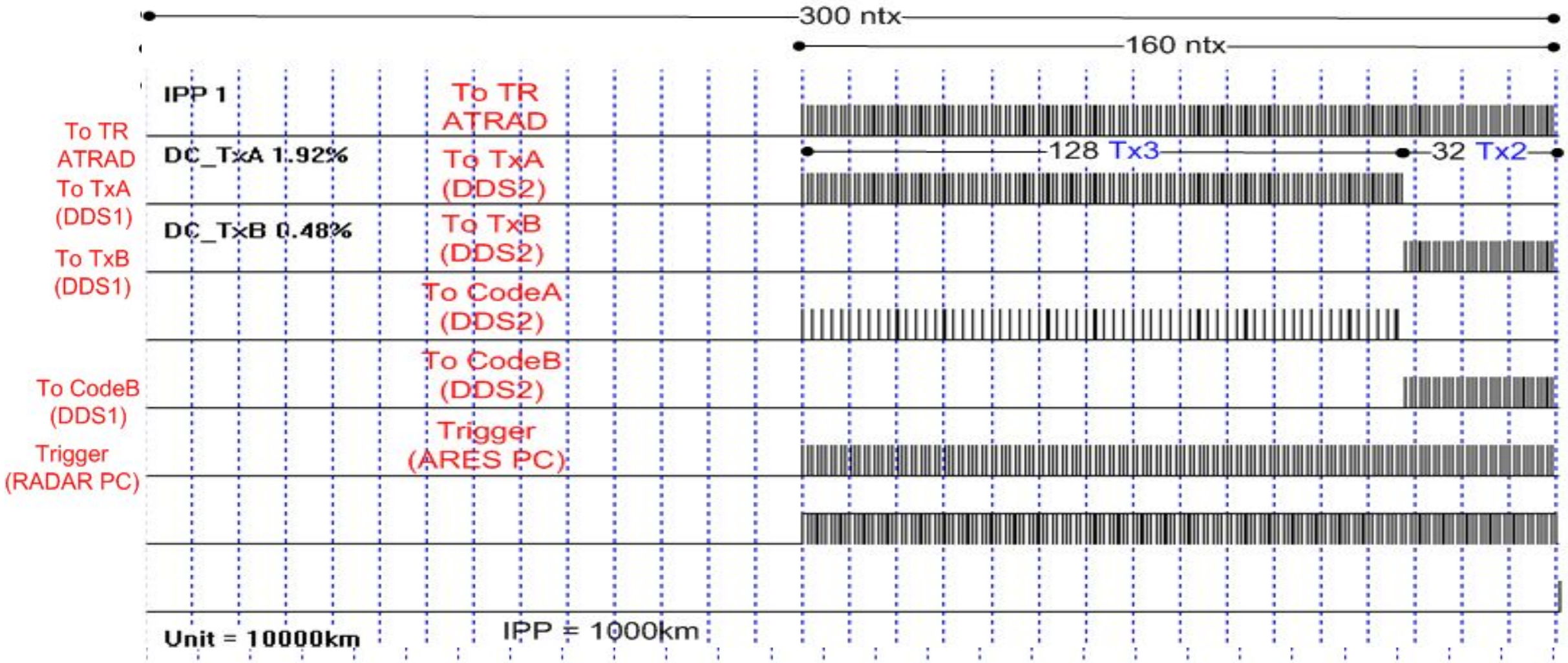


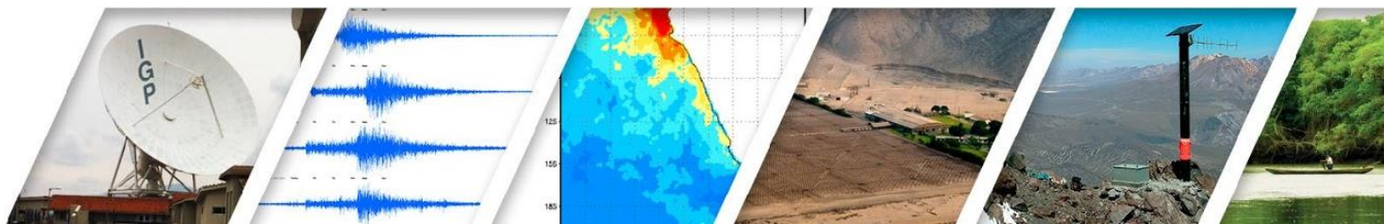
Experiment pulses



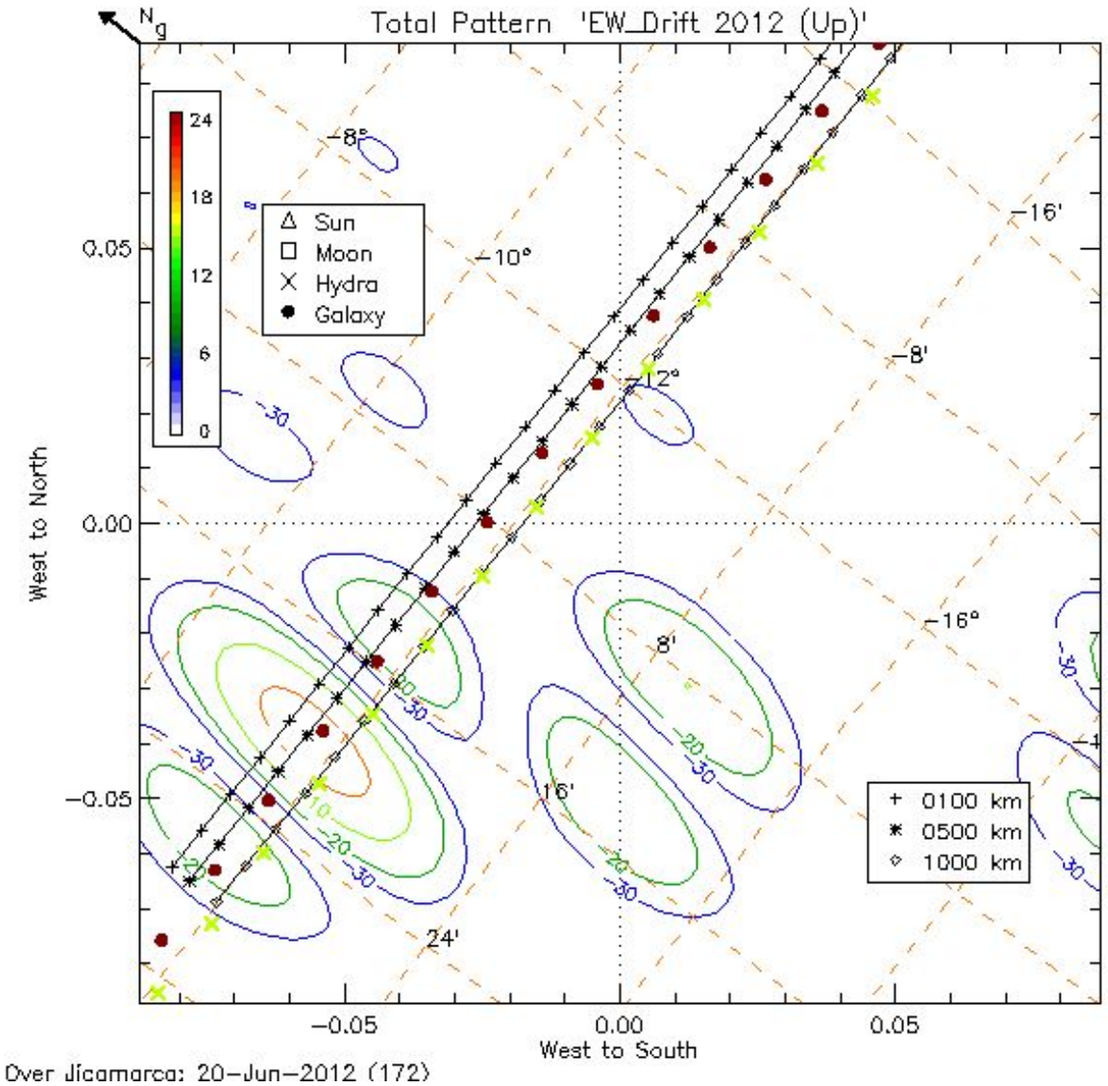


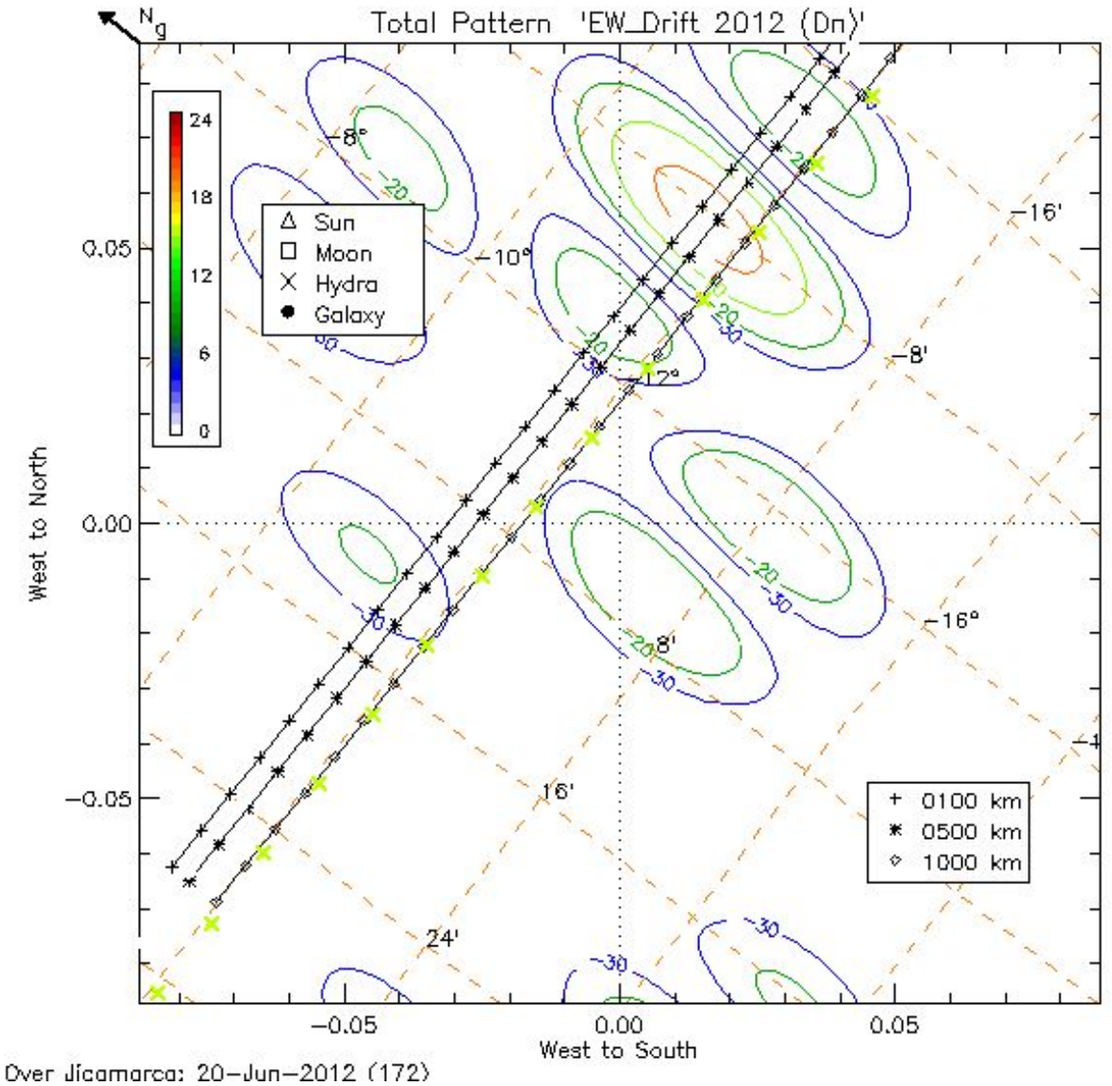
Experiment pulses

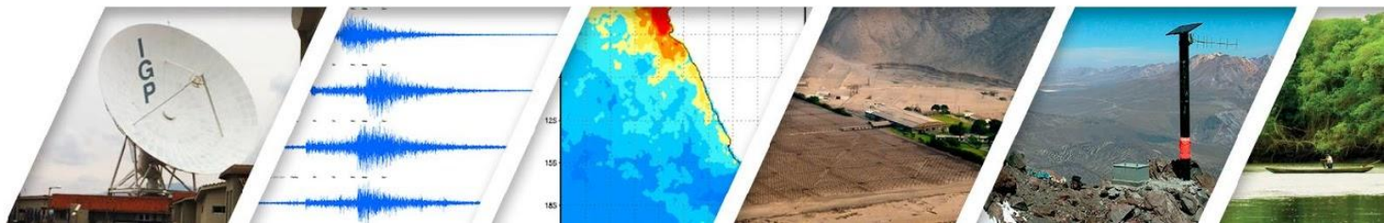


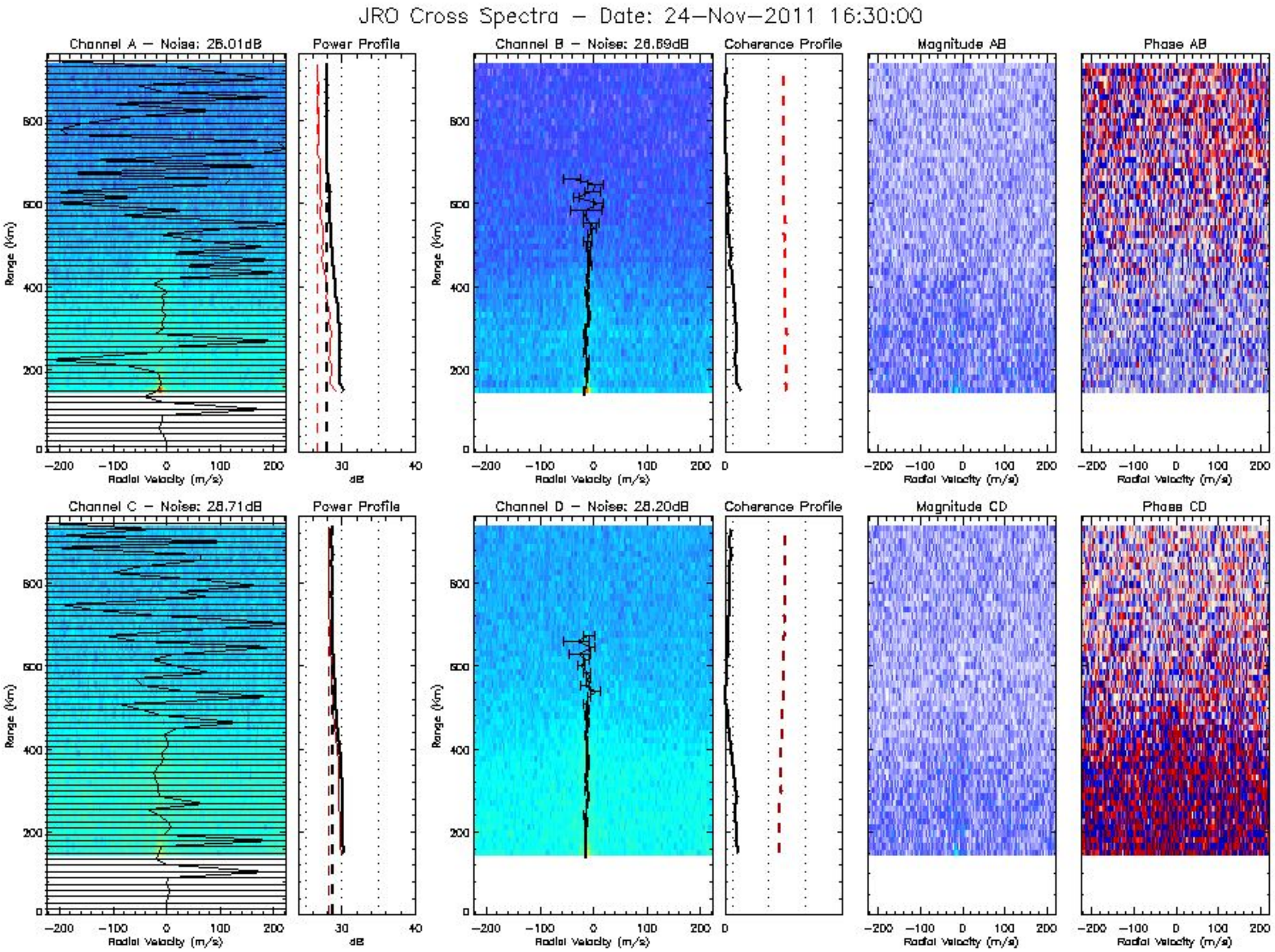


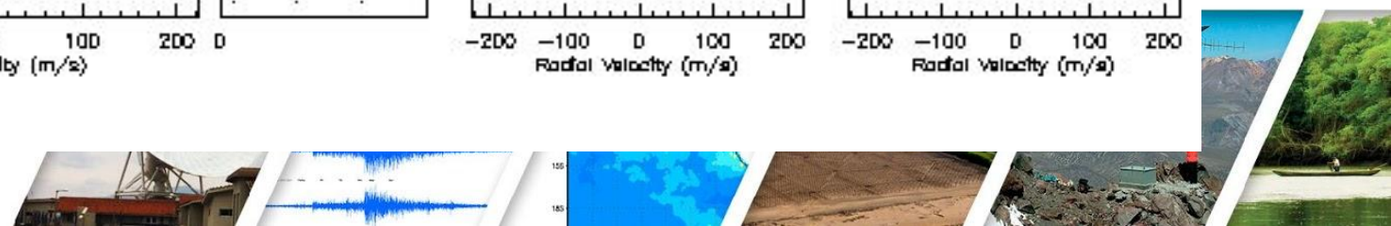
Antenna pattern - EW Drift

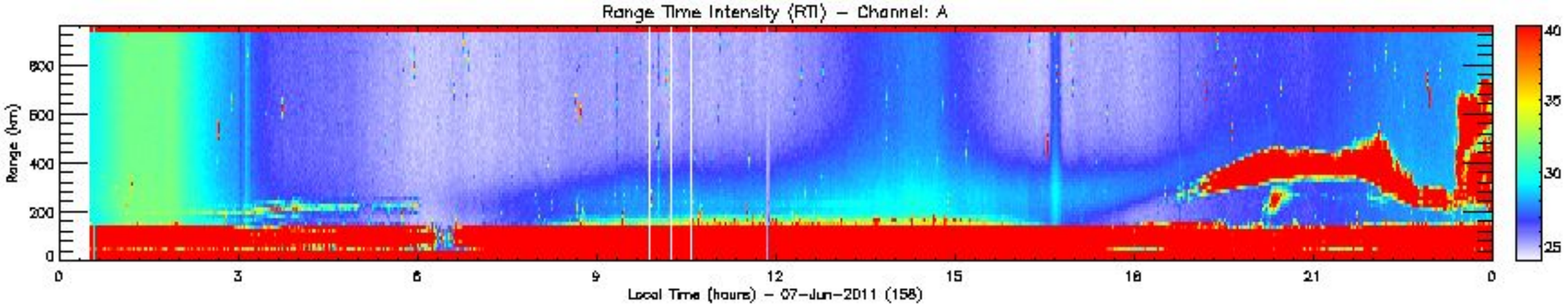


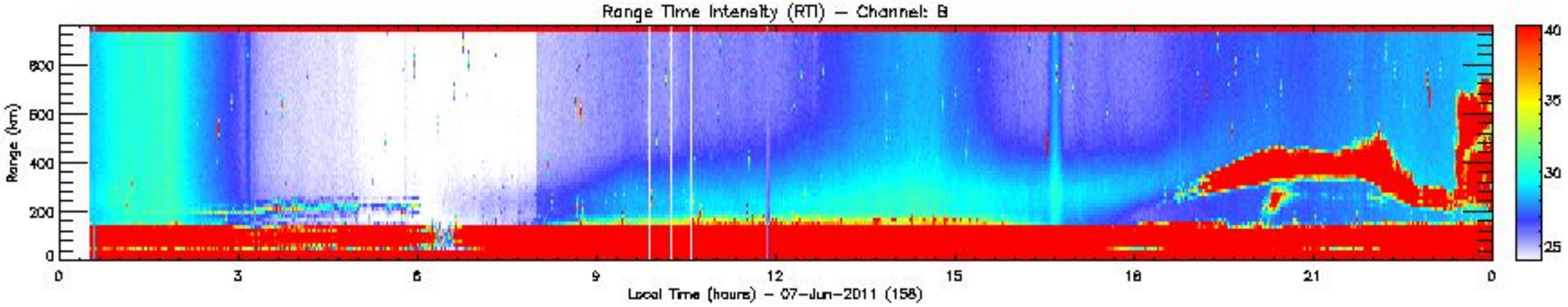


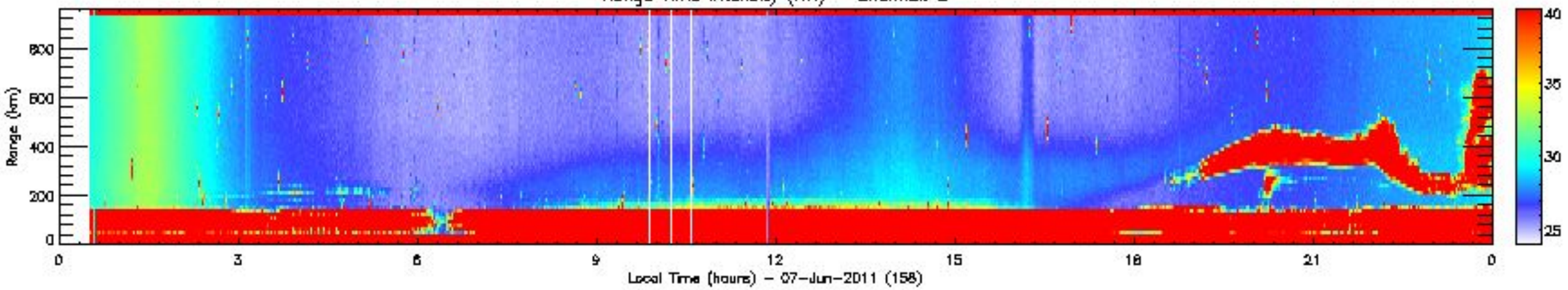


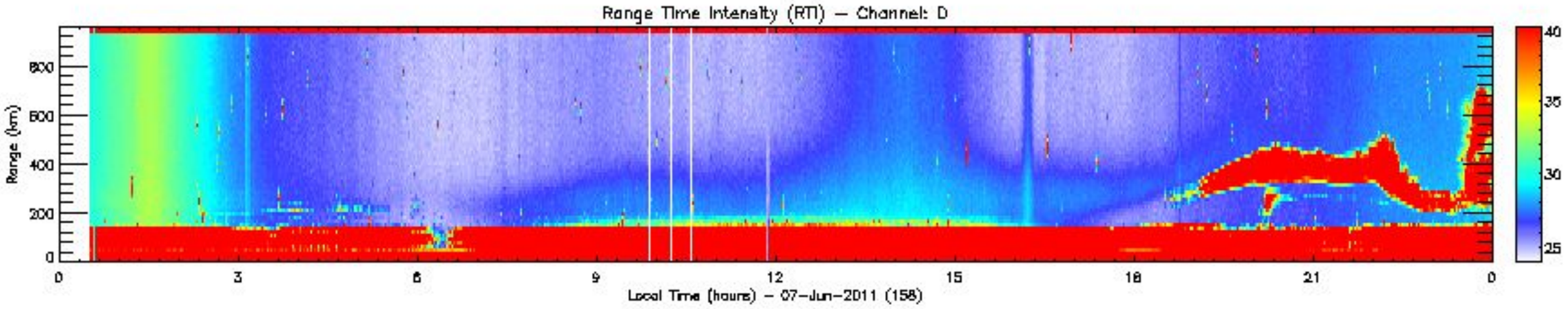

JRO Cross Spectra – Date: 24–Nov–2011 16:30:00
Channel A – Noise: 26.01dB
Power Profile
Channel B – Noise: 26.69dB
Coherence Profile
Magnitude AB
Phase AB
Channel C – Noise: 28.71dB
Power Profile
Channel D – Noise: 28.20dB
Coherence Profile
Magnitude CD
Phase CD
Range (km)
Radial Velocity (m/s)
dB
Batch name: EW_Drifts_28nov2011

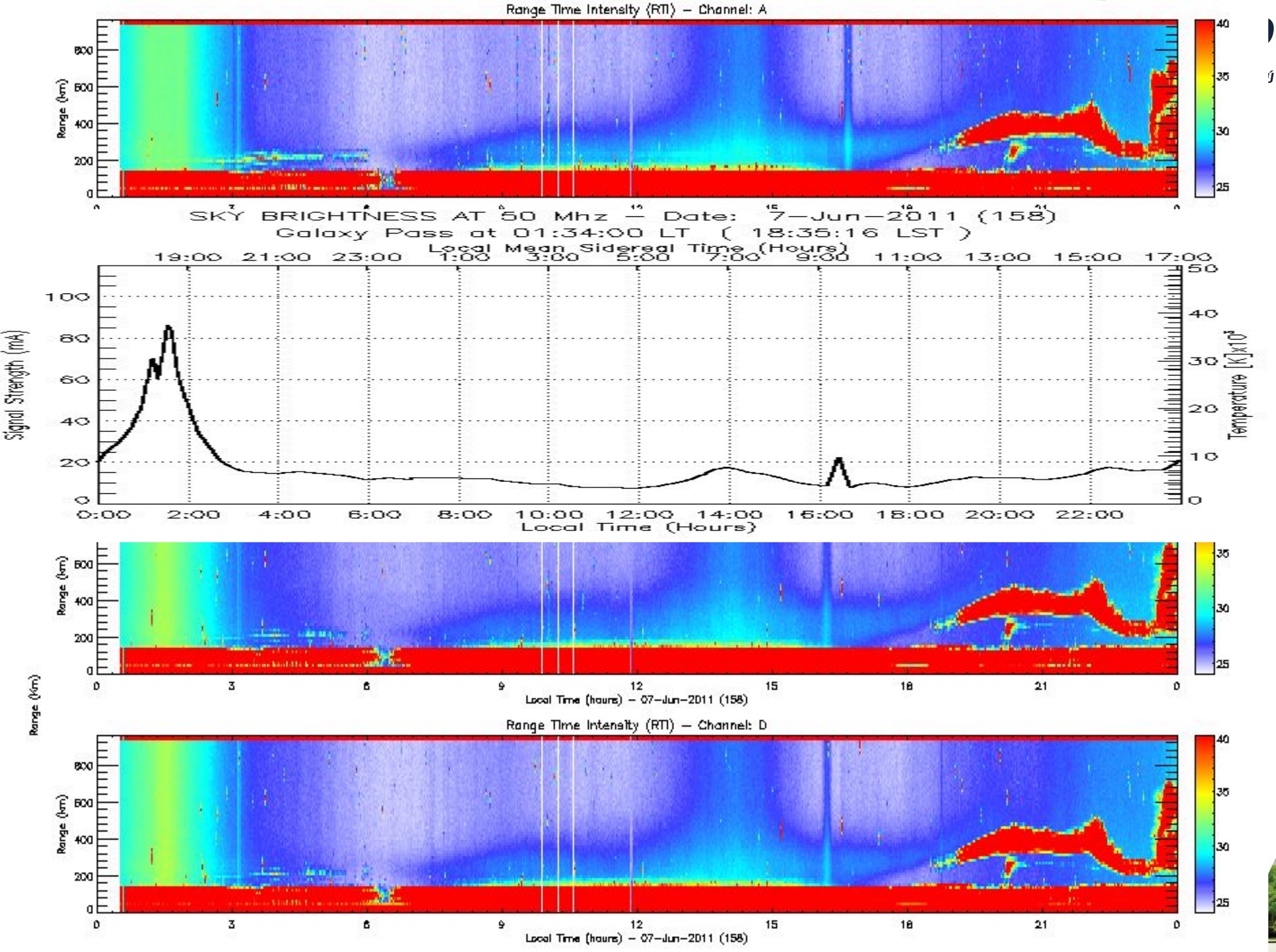



Range Time Intensity (RTI) – Channel: A
Range (km)
0
200
400
600
800
0
3
6
9
12
15
18
21
0
Local Time (hours) – 07-Jun-2011 (158)
25
30
35
40

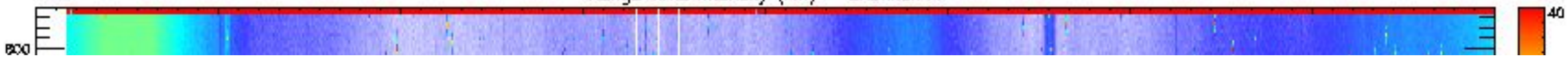

Range Time Intensity (RTI) – Channel: B
Range (km)
0
200
400
600
800
0
3
6
9
12
15
18
21
0
Local Time (hours) – 07-Jun-2011 (158)
25
30
35
40


Range Time Intensity (RTI) – Channel: C
Range (km)
0
200
400
600
800
0
3
6
9
12
15
18
21
0
Local Time (hours) – 07-Jun-2011 (158)
25
30
35
40


Range Time Intensity (RTI) – Channel: D
Range (km)
0
200
400
600
800
0
3
6
9
12
15
18
21
0
Local Time (hours) – 07-Jun-2011 (158)
25
30
35
40

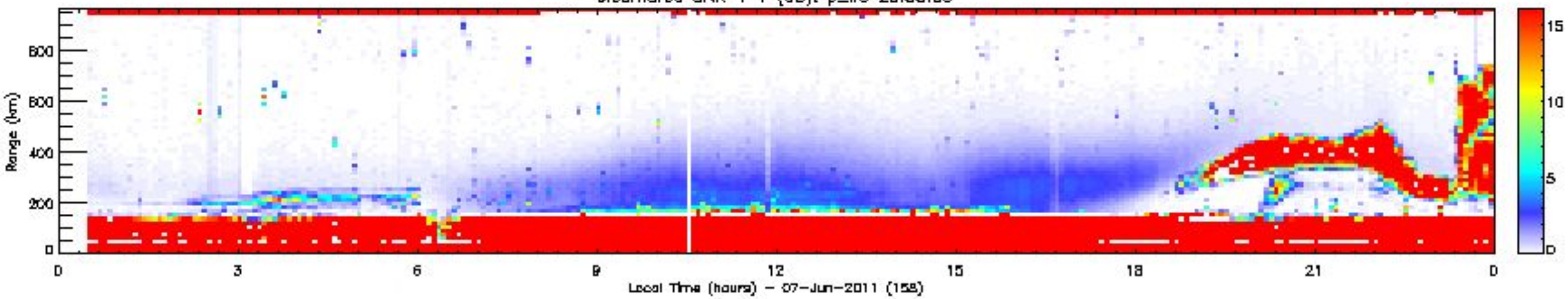

Range Time Intensity (RTI) – Channel: A
Range (km)
SKY BRIGHTNESS AT 50 Mhz – Date: 7–Jun–2011 (158)
Galaxy Pass at 01:34:00 LT (18:35:16 LST)
Local Mean Sidereal Time (Hours)
19:00 21:00 23:00 1:00 3:00 5:00 7:00 9:00 11:00 13:00 15:00 17:00
Signal Strength (mA)
Temperature [K]x10⁴
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00
Local Time (Hours)
Local Time (hours) – 07–Jun–2011 (158)
Range Time Intensity (RTI) – Channel: D

Range Time Intensity (RTI) – Channel: A

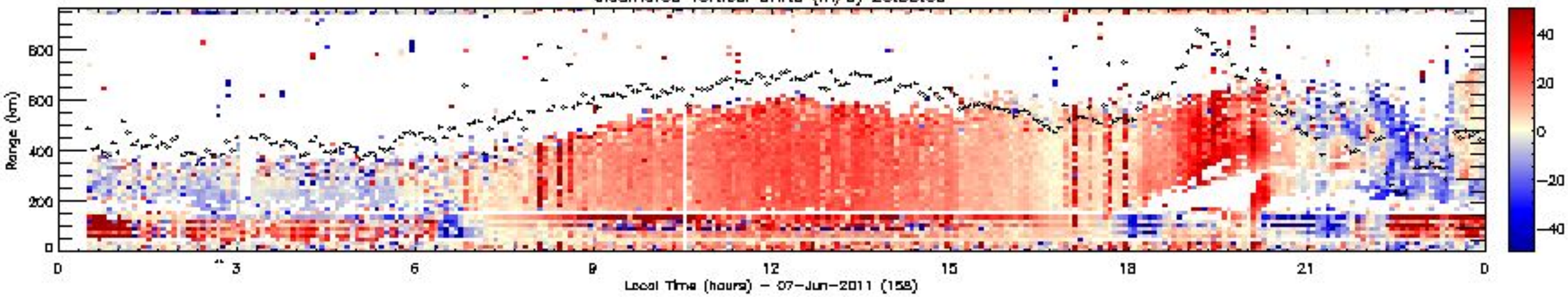


Drifts ISR over Jicamarca – Date: 07–Jun–2011

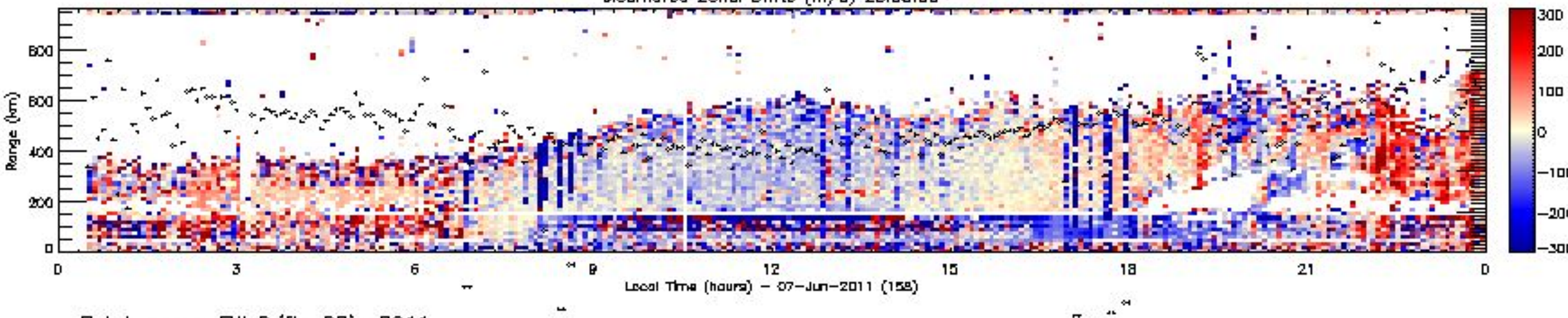
Jicamarca SNR + 1 (dB): p_w0 23:55:00



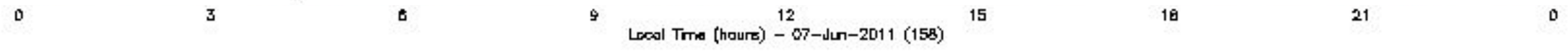
Jicamarca Vertical Drifts (m/a) 23:55:00



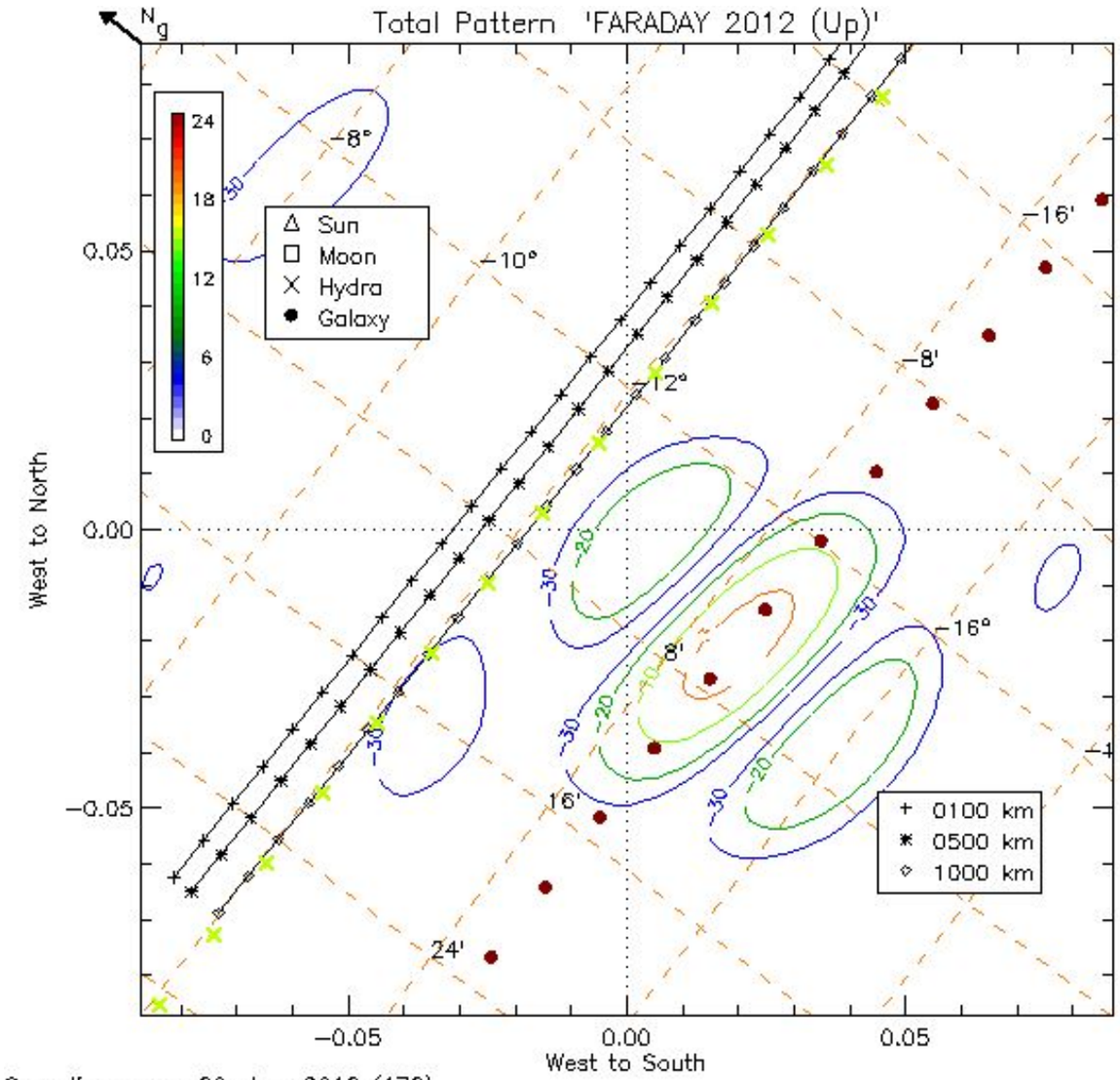
Jicamarca Zonal Drifts (m/a) 23:55:00

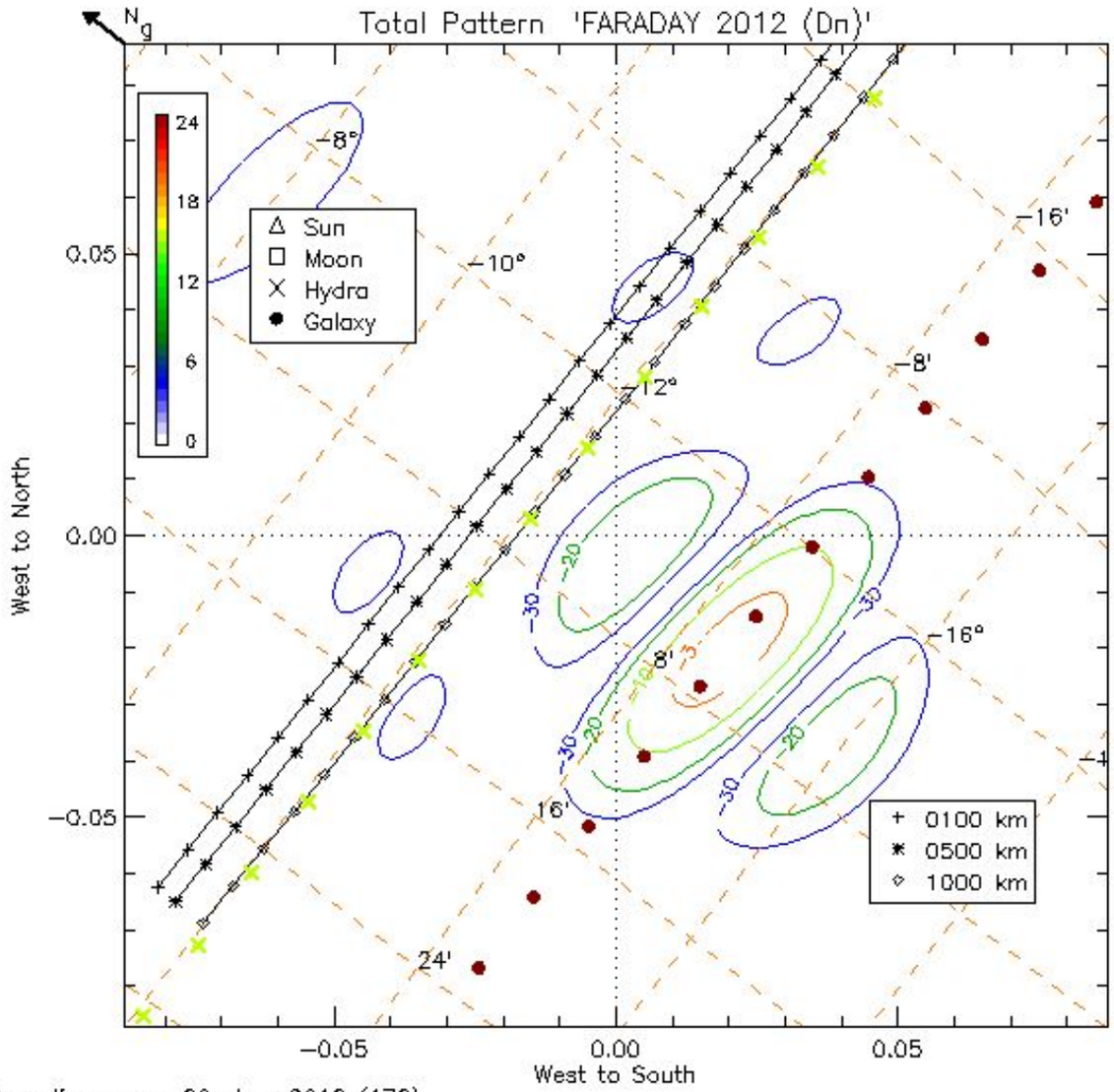


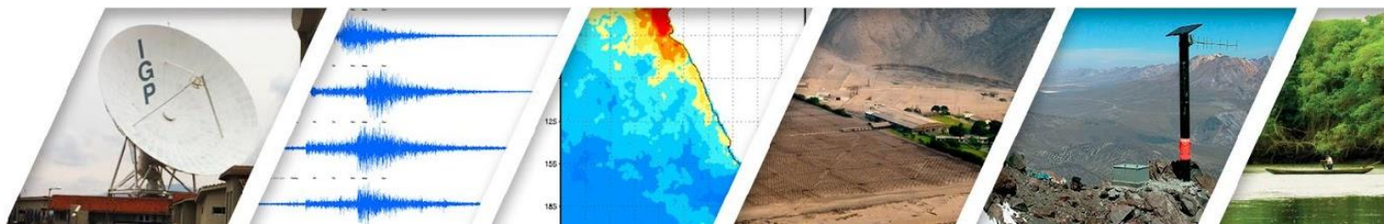
Batch name: EW_Drifts_02jun2011



Antenna pattern - DP Faraday

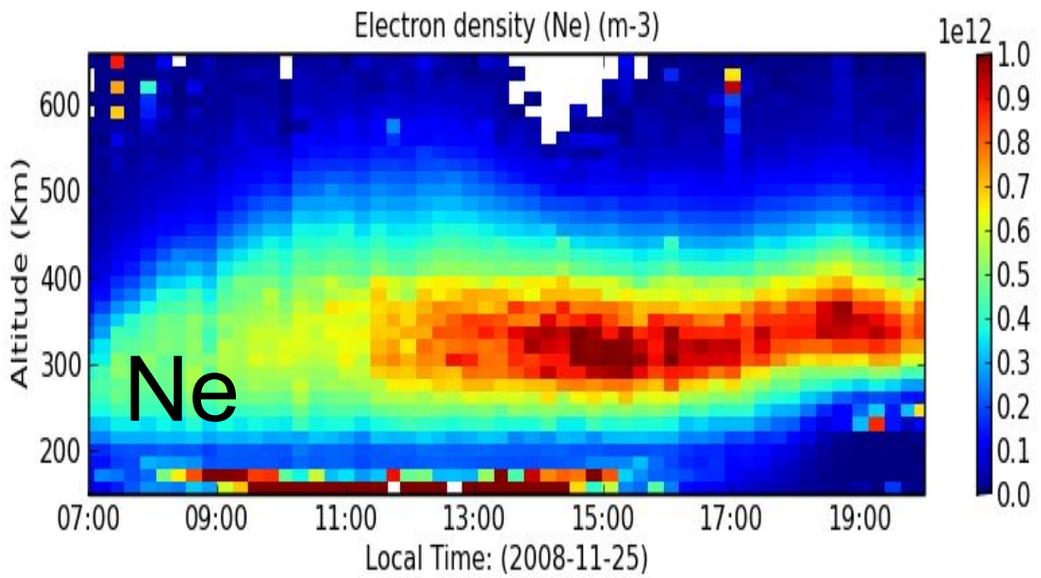


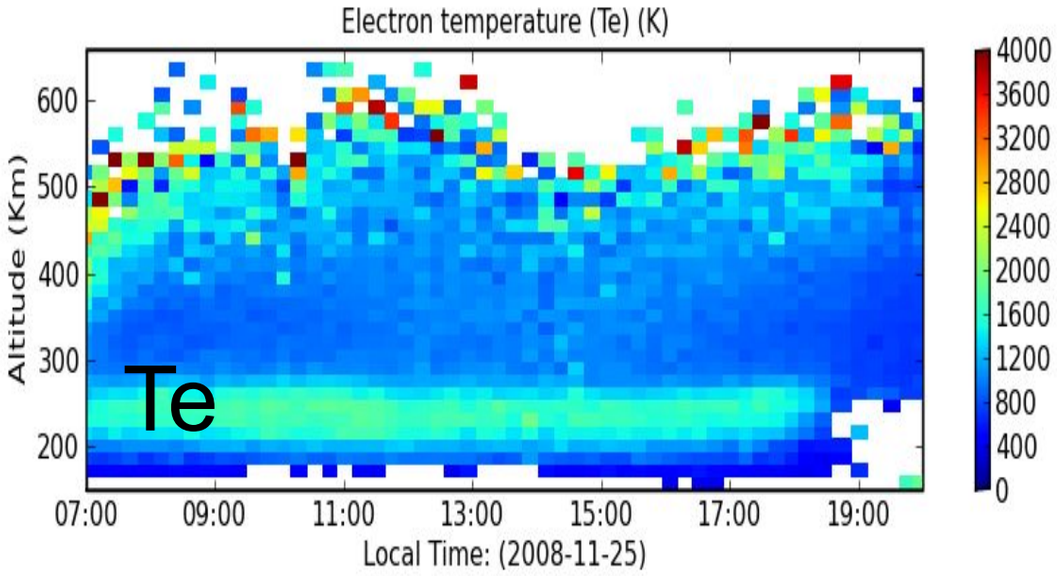


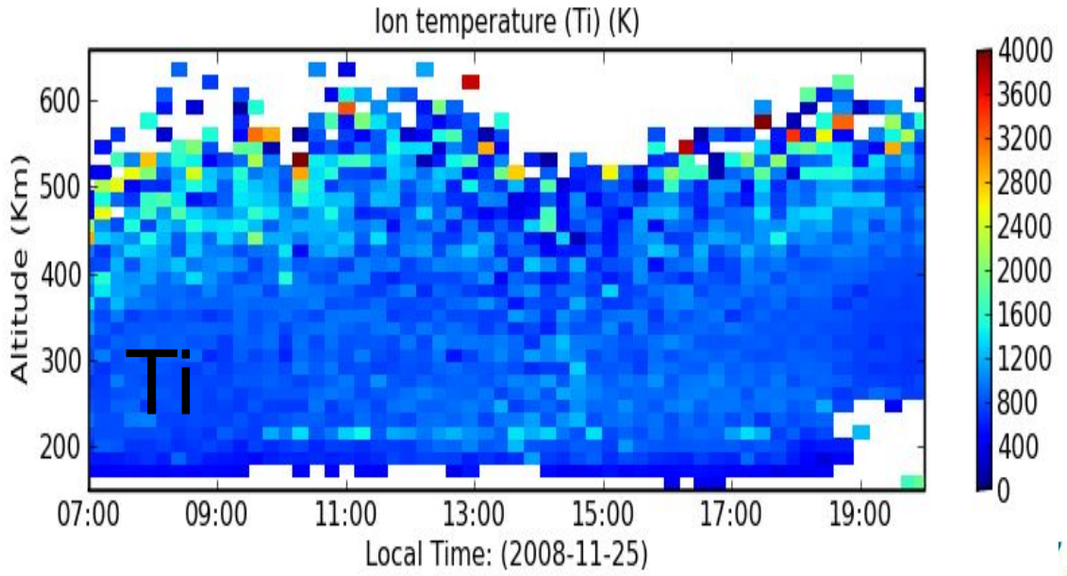


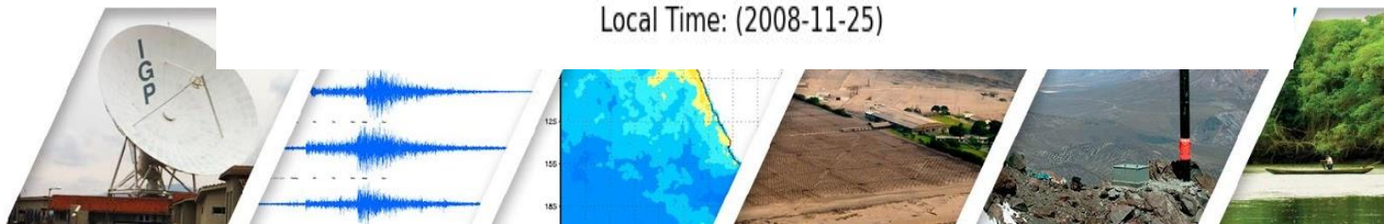
Faraday mode: Off perpendicular ISR

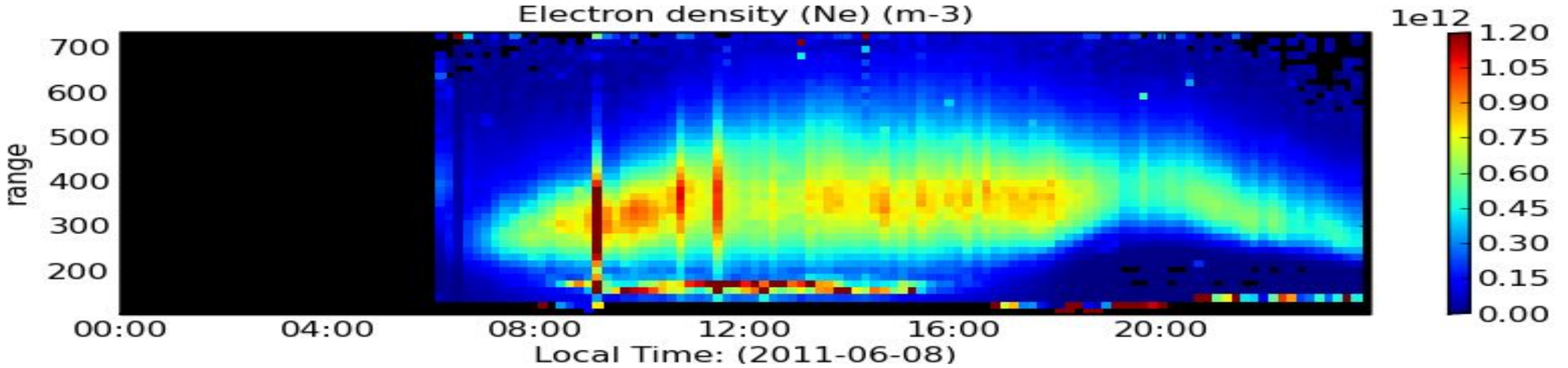
- Ne profiles are obtained from the phase difference between circular propagation modes.
- Te and Ti are obtained from fits of measured ISR ACFs.
- Technique developed by Farley (1969) and improved by Hysell et al (2008).

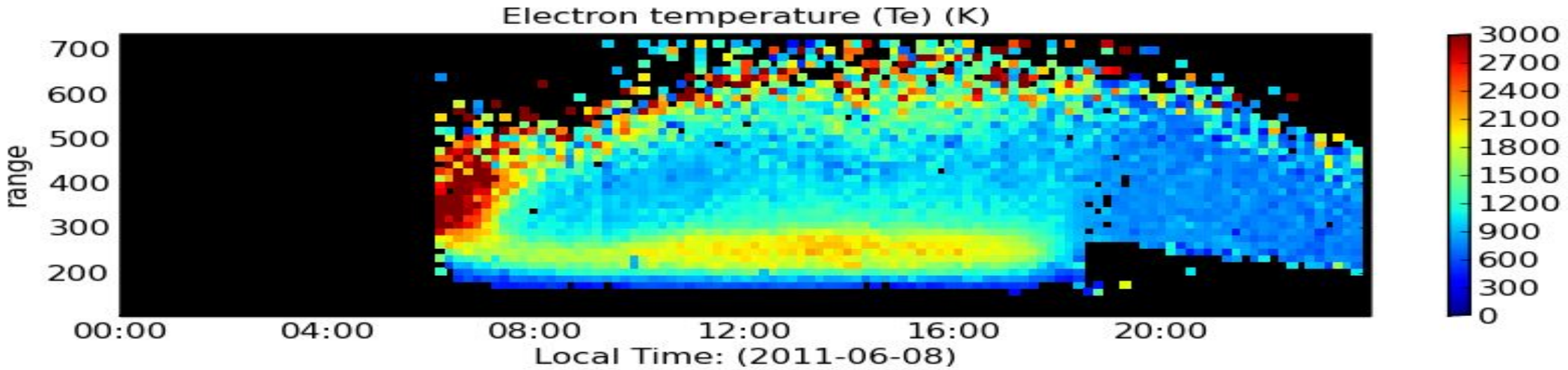


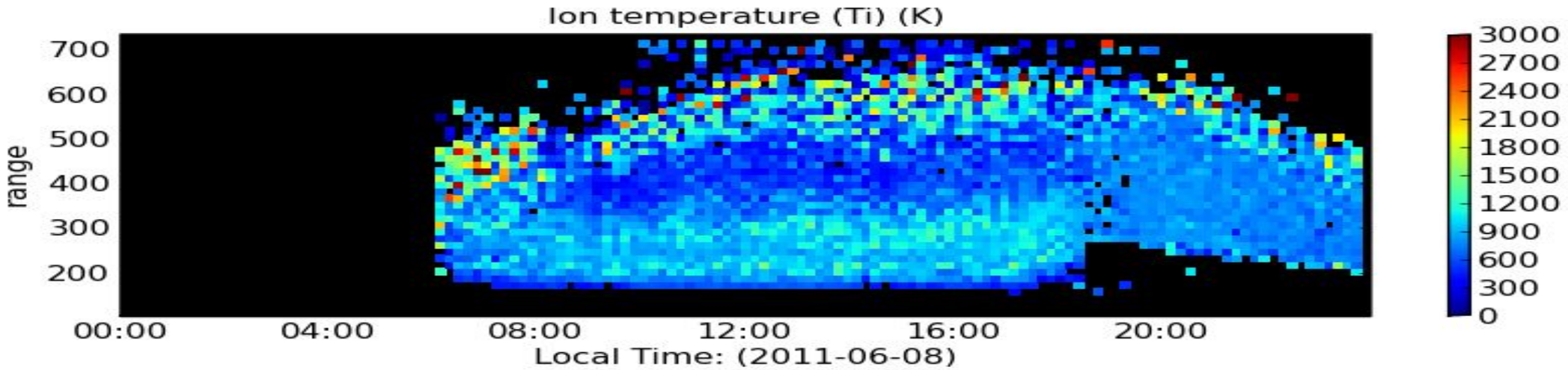






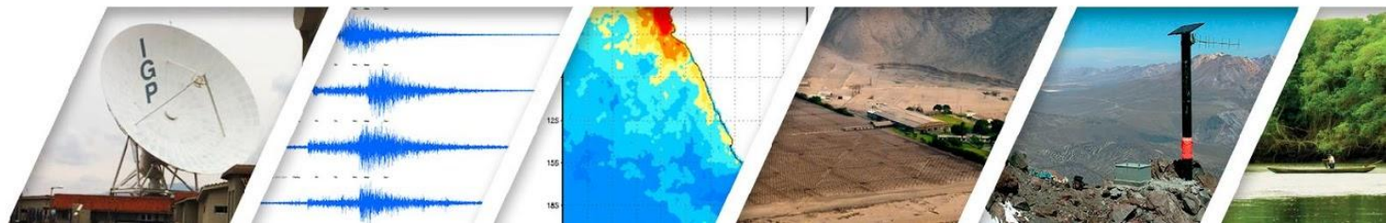

Electron density (Ne) (m-3)
1e12
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
range
700
600
500
400
300
200
00:00
04:00
08:00
12:00
16:00
20:00
Local Time: (2011-06-08)


Electron temperature (Te) (K)
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
range
700
600
500
400
300
200
00:00
04:00
08:00
12:00
16:00
20:00
Local Time: (2011-06-08)


Ion temperature (Ti) (K)
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
range
700
600
500
400
300
200
00:00
04:00
08:00
12:00
16:00
20:00
Local Time: (2011-06-08)

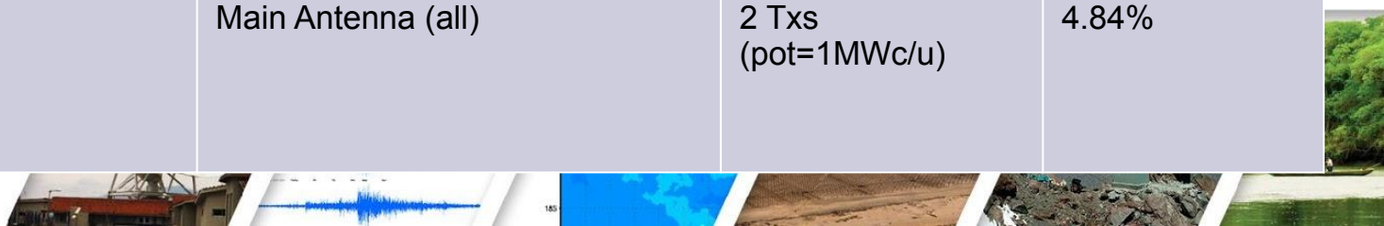
INSTITUTO GEOFÍSICO DEL PERÚ

COHERENT SCATTERING ECHOES

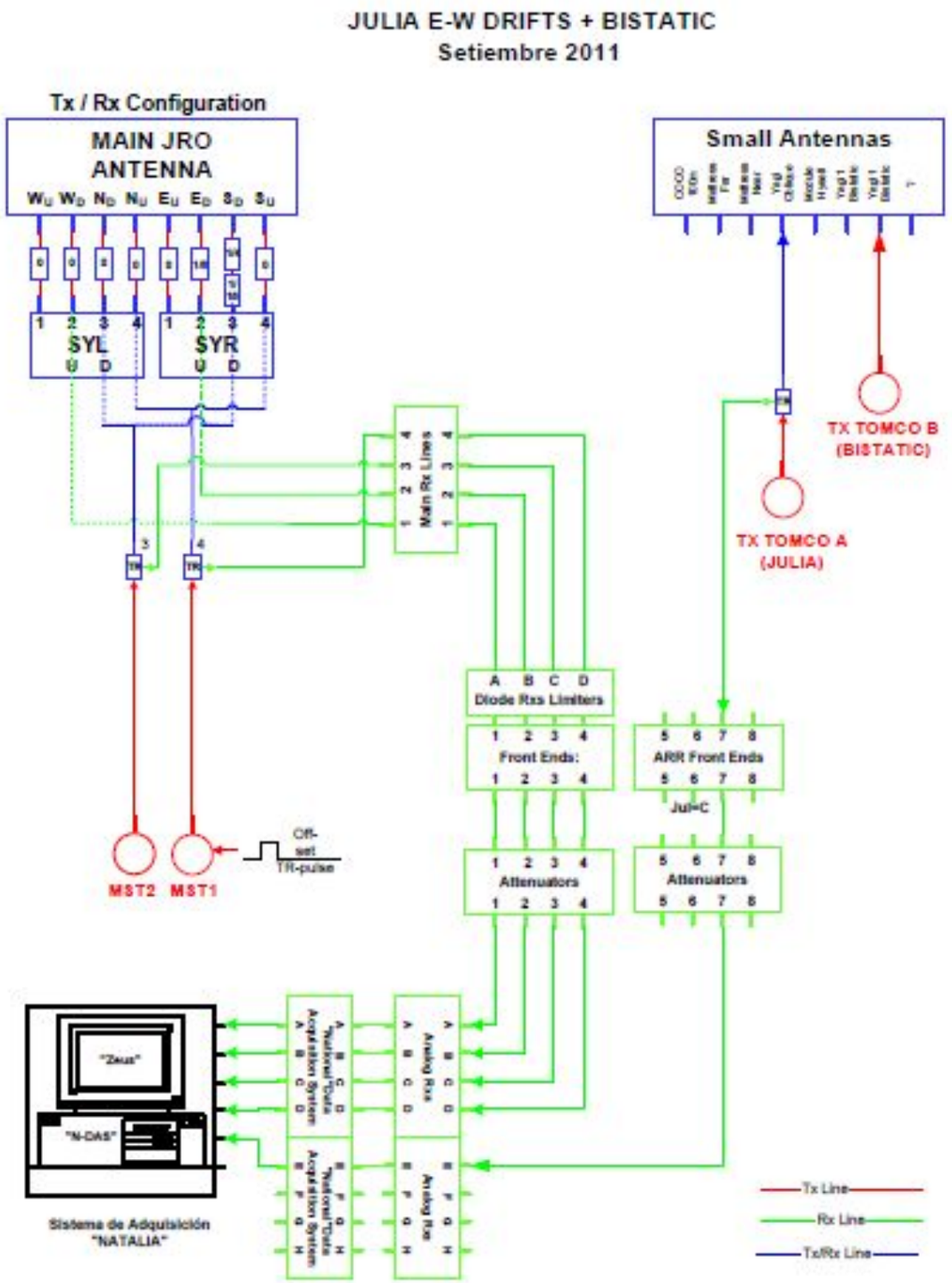


Experiments summary

EXPERIMENTS		MEASURED PARAMETERS	RANGE (km)	RESOLUTION (HEIGHT, TIME)	ANTENNA	TRANSMITTER (POWER)	Duty Cycle (%)
JASMET		Zonal and Medirional drift		5km,1 h	Yagis Array (4tx, 5 rx)	TOMCO (20kW)	4.8%
METEORS		Meteor characteristics	80-120	150m,	Main Antenna -Up polarization (ON-AXIS)	2 Txs (pot=1MWc/u)	3% (BARKER13)
JULIA EW	150km	Drifts 150km	130-180	3km , 5min	Main Antenna (2 Quarters)	3 MST (20kW c/u)	0.8%
	EEJ (Yagi)		80-100	1.5km	Oblique Yagi Array	1 TOMCO (12kW)	0.4%
	ESF	Drift ESF	0-937.5	3.75km, 25seg	Main Antenna (2 quarters)	1 MST (20kW)	0.4%
IMAGING		EEJ 150km	80-120 / 130-180	150m / 300m	8 modules of Main Antenna	MST 2Tx (1MW)	0.2% / 4%
		ESF	0-937.5	1.5km		2 ATRAD (16kW)	8.96%
BISTATIC RADAR		Electron density	80-120	600m, 5min	Yagis Array (Jicamarca y Ica)	TOMCO (12kW)	2.08%
MST-ISR 2 (MST)		Mesosphere Drift	10-180	150m	Main Antenna (all)	2 Txs (pot=1MWc/u)	4.84%



JULIA EW - 150km echoes



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

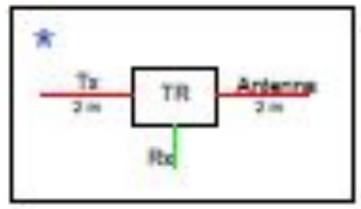
West Quarter

X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

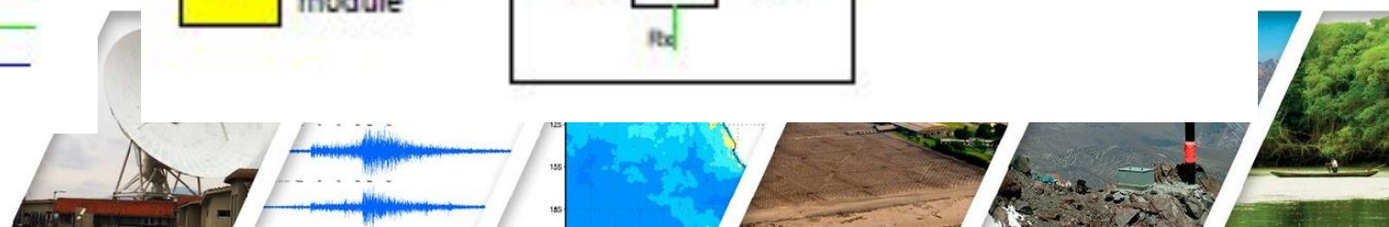
South Quarter

4/5	4/4	E 4/2"	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

H Hysell module

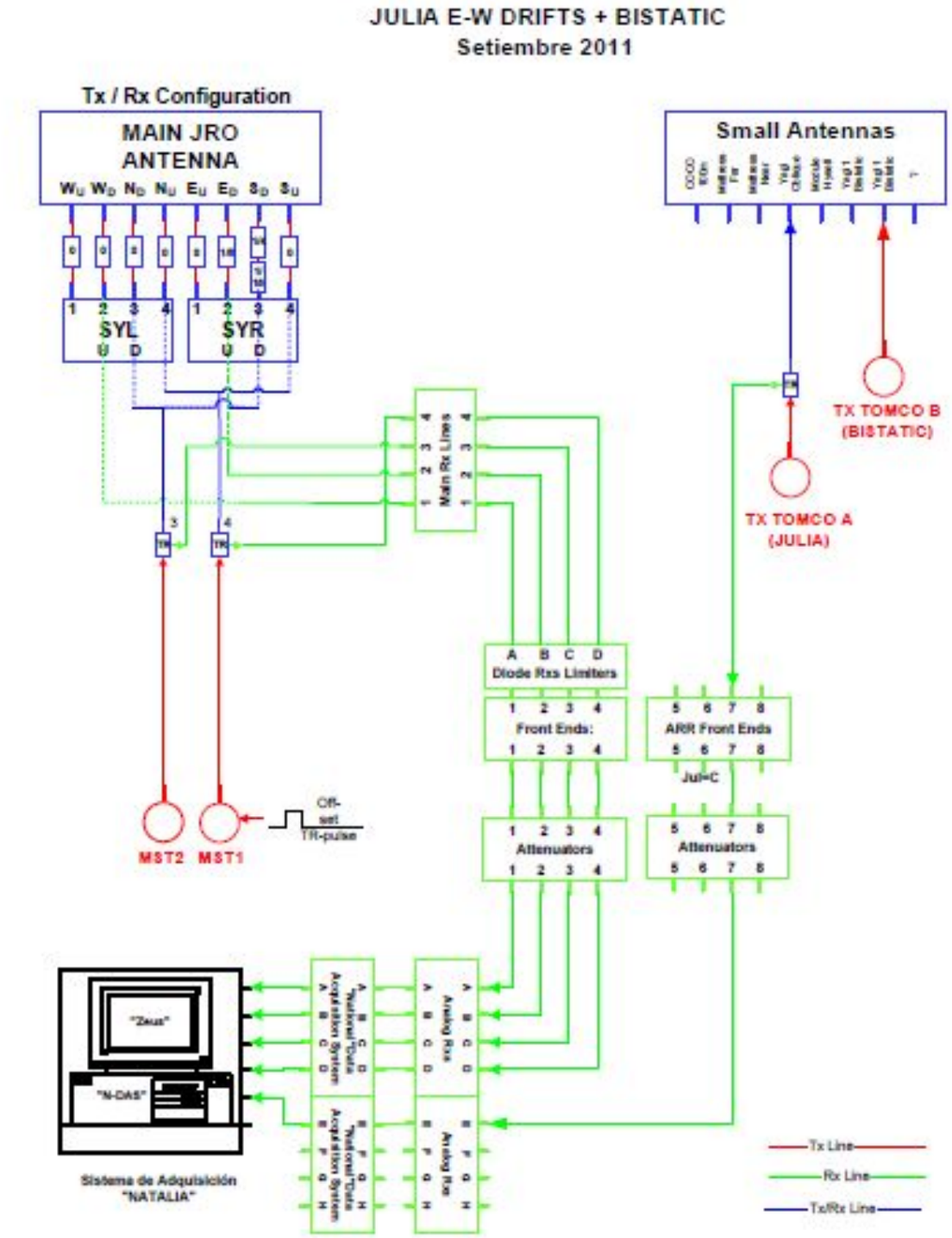


Imaging modules (Up polarization)



JULIA EW - 150km echoes

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

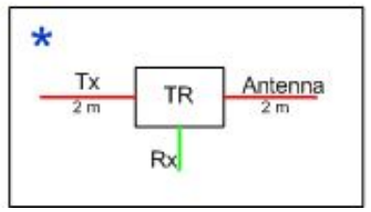
West Quarter

X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

South Quarter

4/5	4/4	E 4/2*	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

H Hysell module

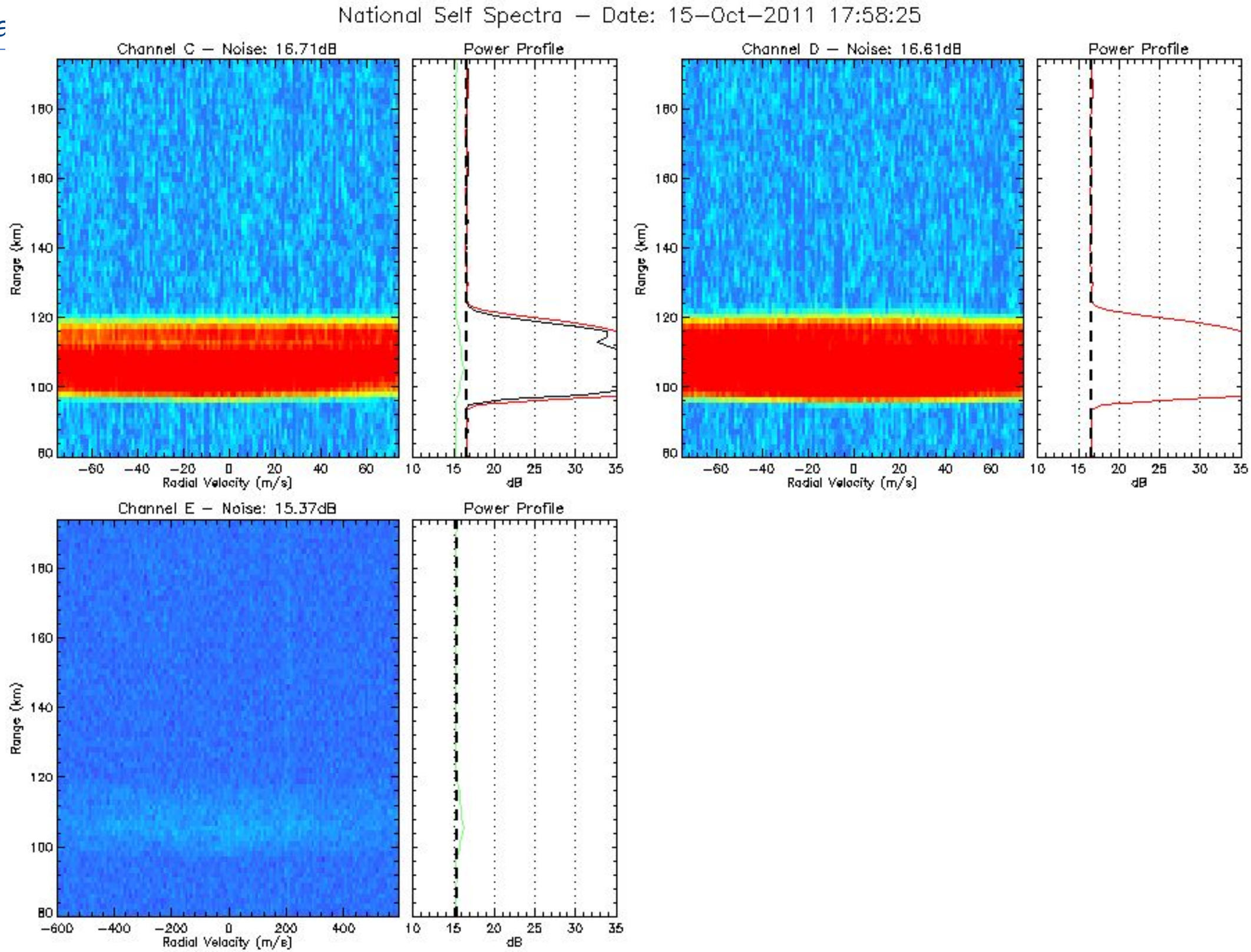


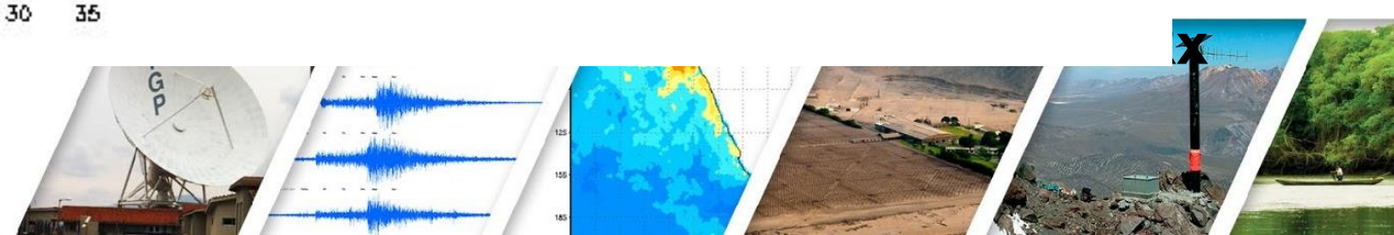
Imaging modules (Up polarization)

Tx and Rx

JULIA FW - 150km echoes

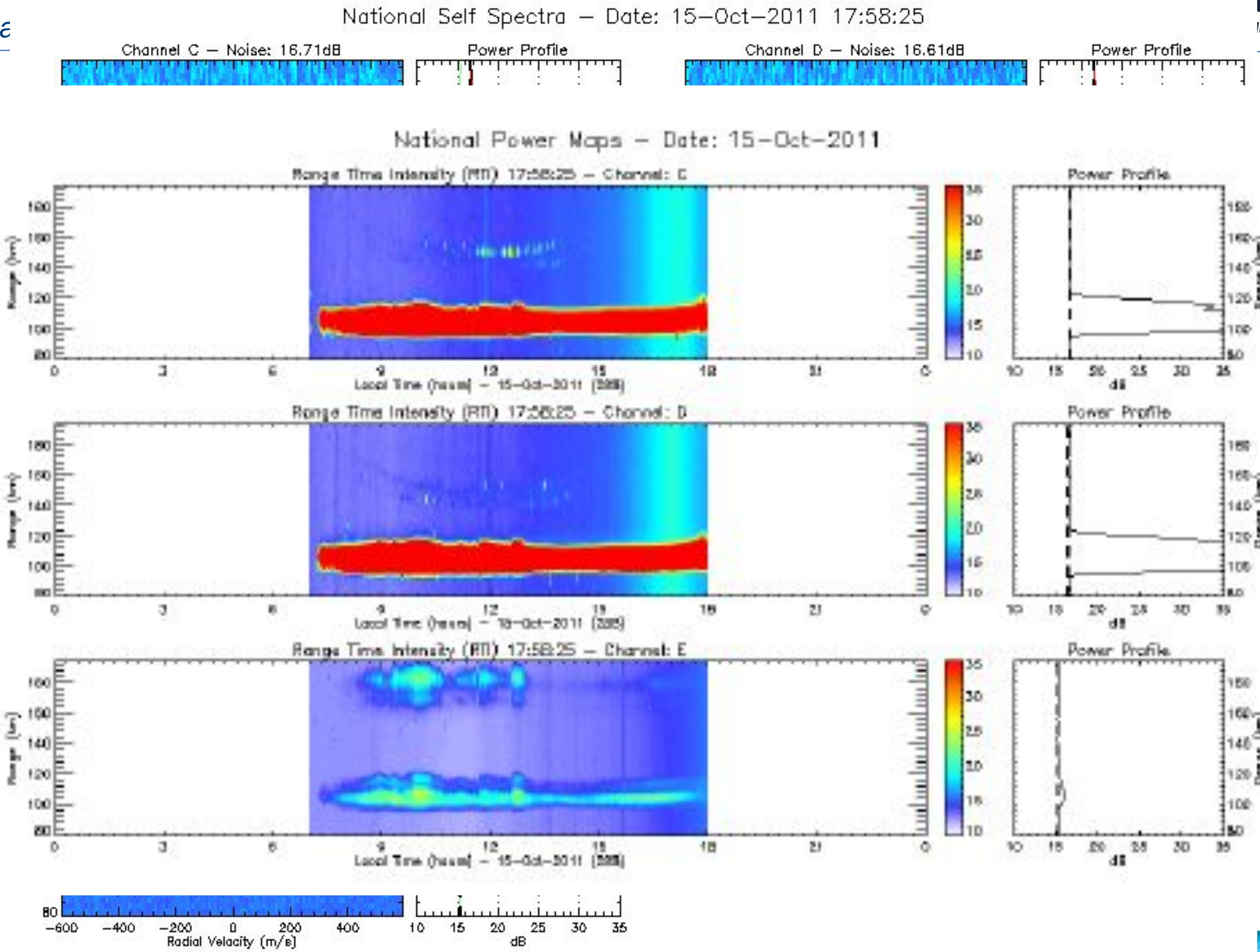
Jicamarca

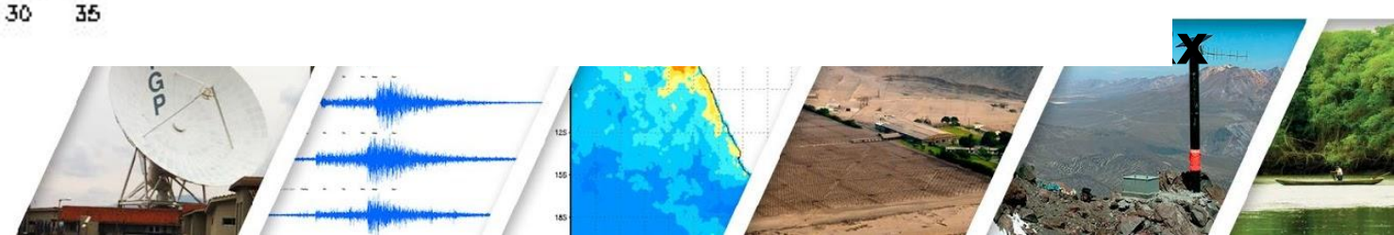




JULIA FW - 150km echoes

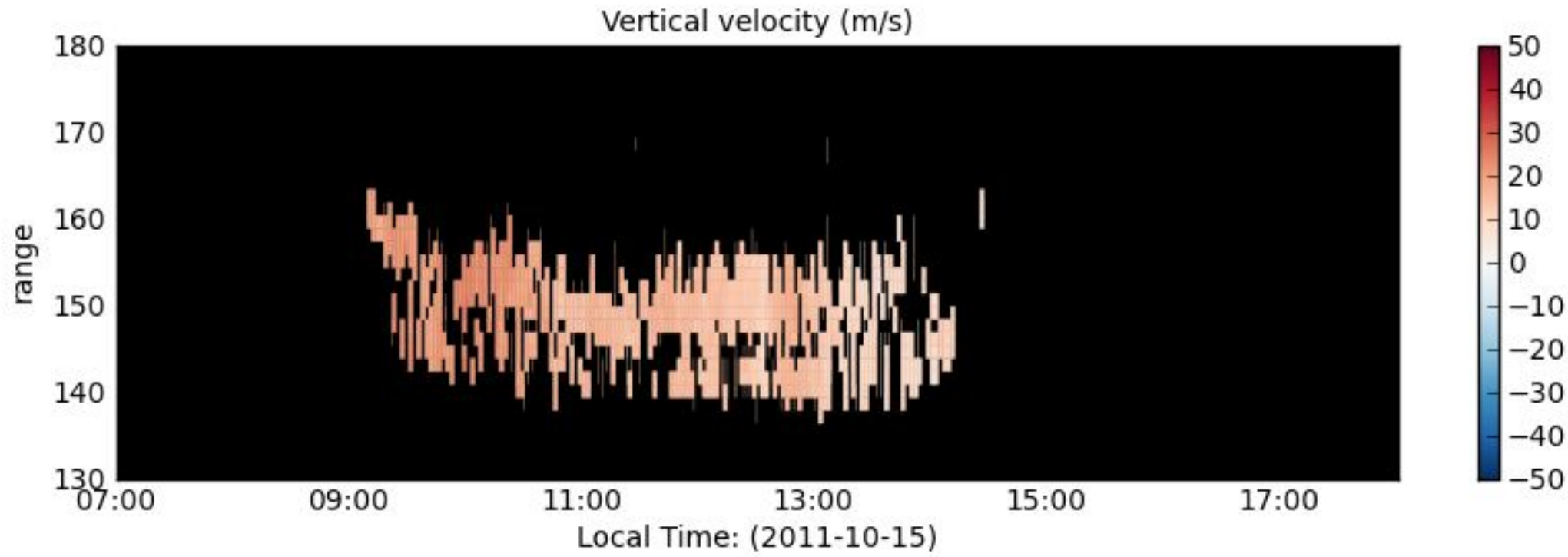
Jicamarca

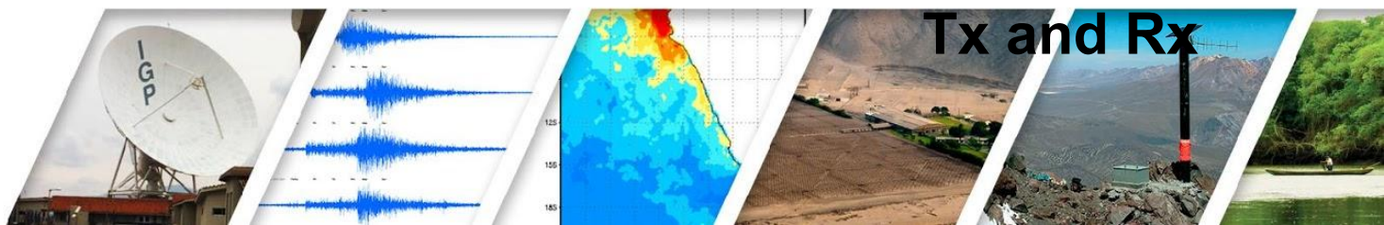




JULIA EW - 150km echoes

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

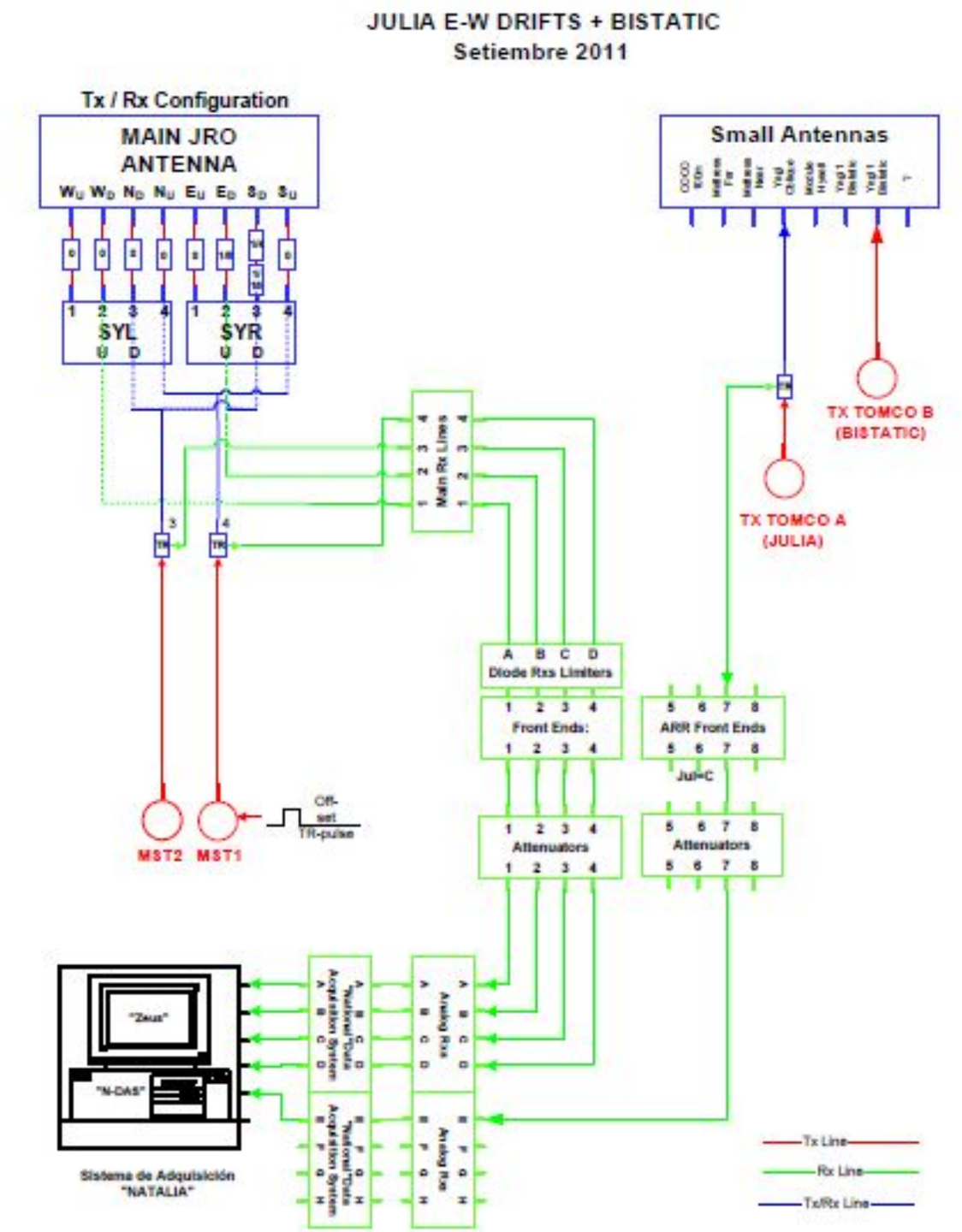




JULIA EW - ESF

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

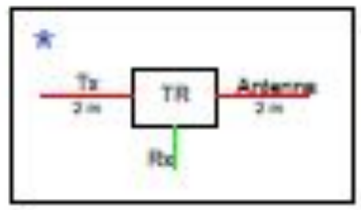
West Quarter

X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

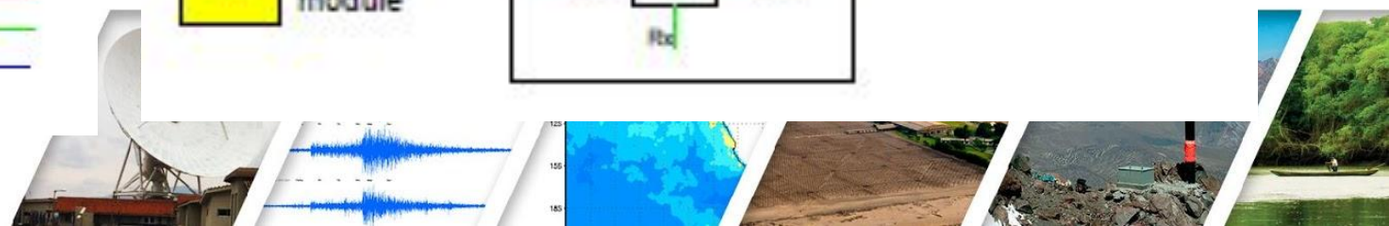
South Quarter

4/5	4/4	E 4/2"	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

H Hysell module



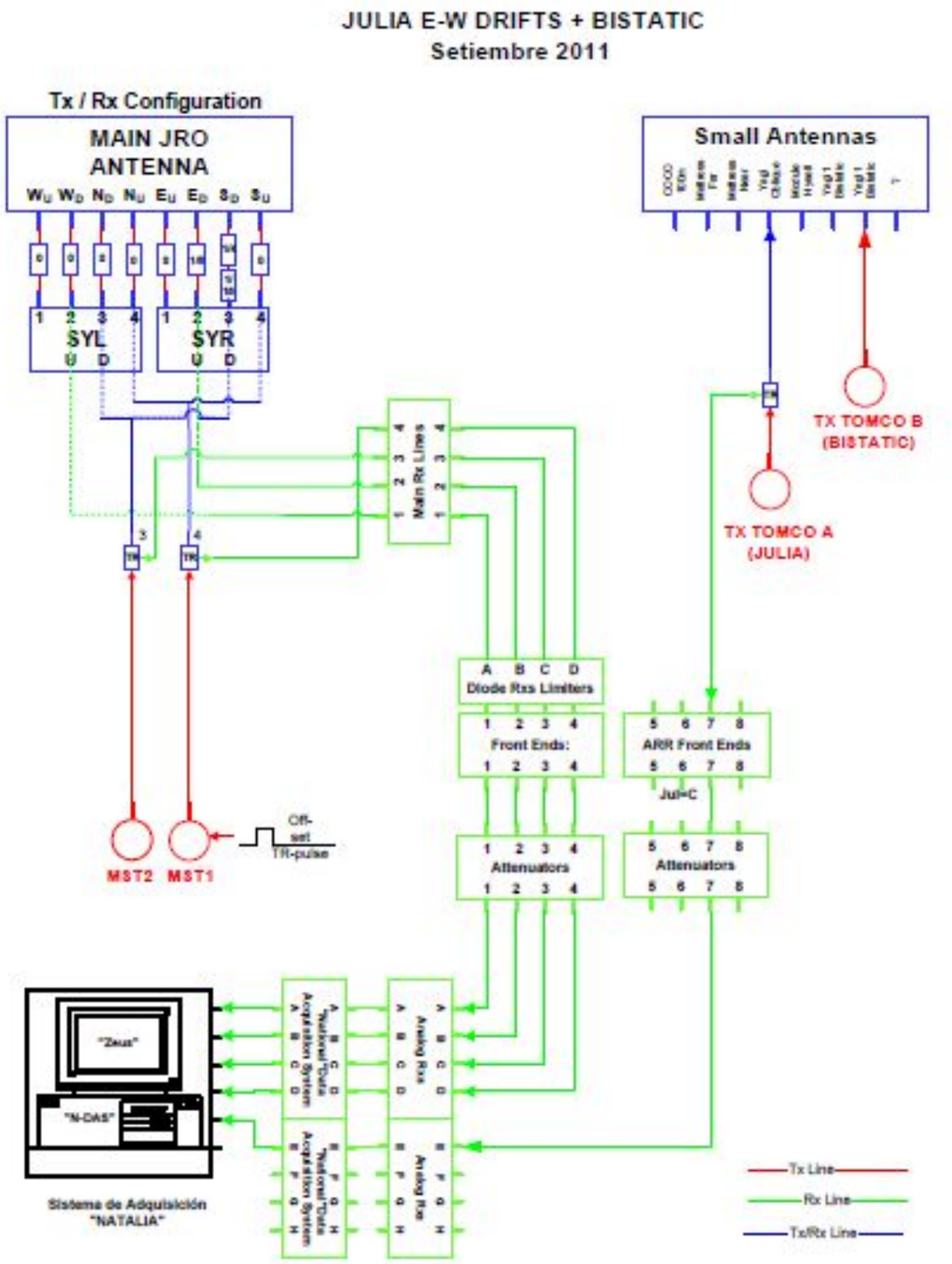
Imaging modules (Up polarization)



JULIA EW - ESF

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

West Quarter

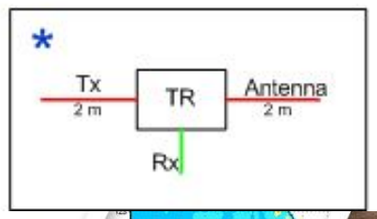
X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

South Quarter

4/5	4/4	4/2*	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

Tx (down)

H Hysell module

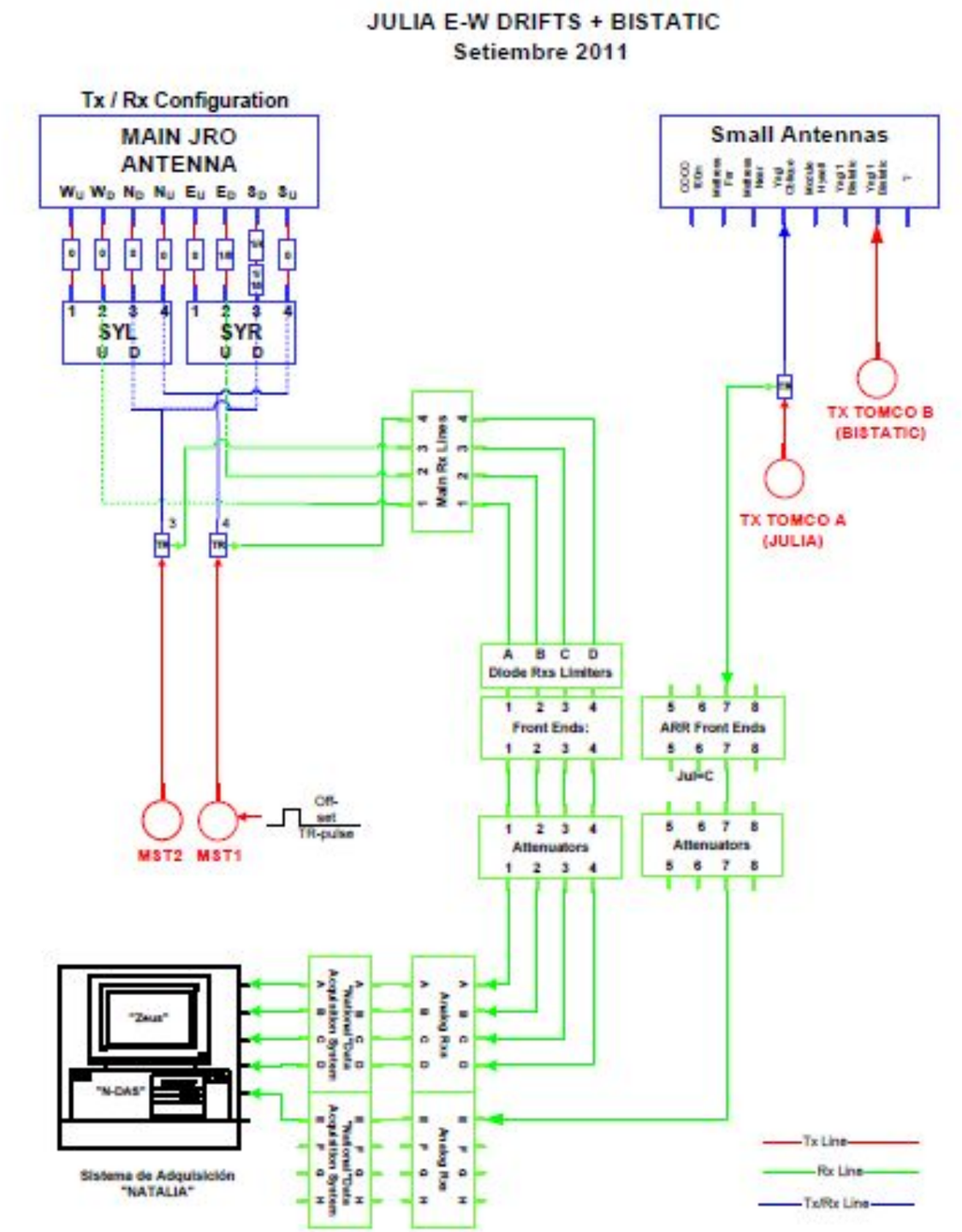


Imaging modules (Up polarization)

JULIA EW - ESF

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

West Quarter

X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

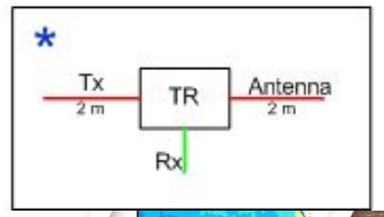
South Quarter

4/5	4/4	4/2*	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

Tx (down)

Rx (down)

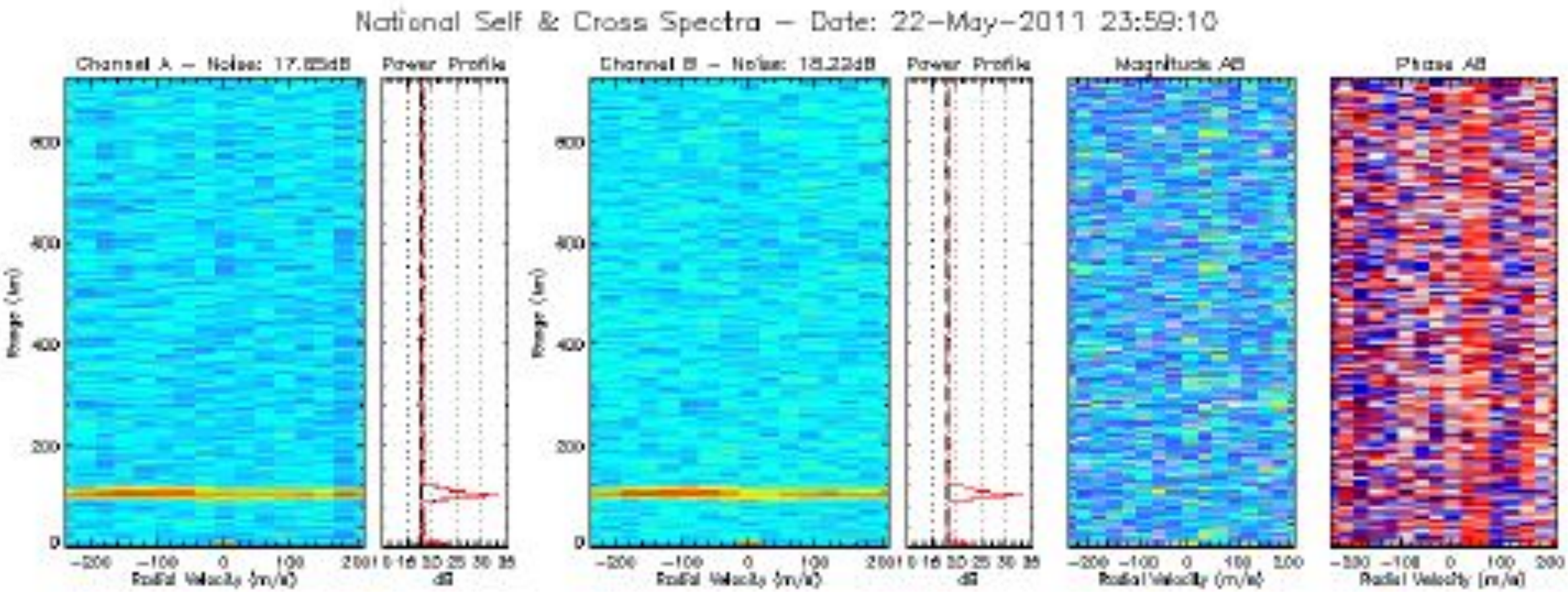
Imaging modules (Up polarization)

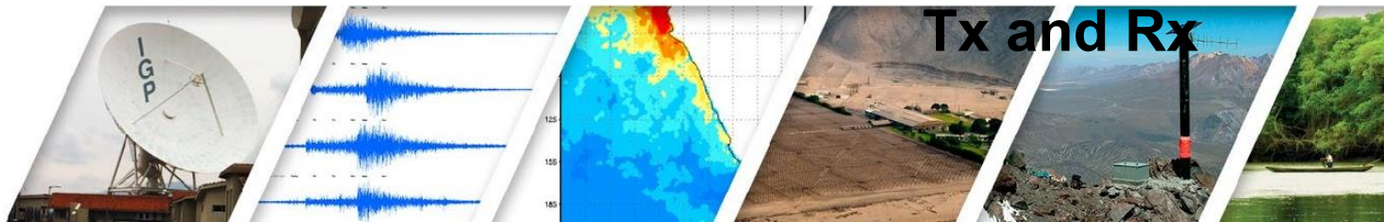


JULIA EW - ESF

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

INSTITUTO GEOFÍSICO DEL PERÚ





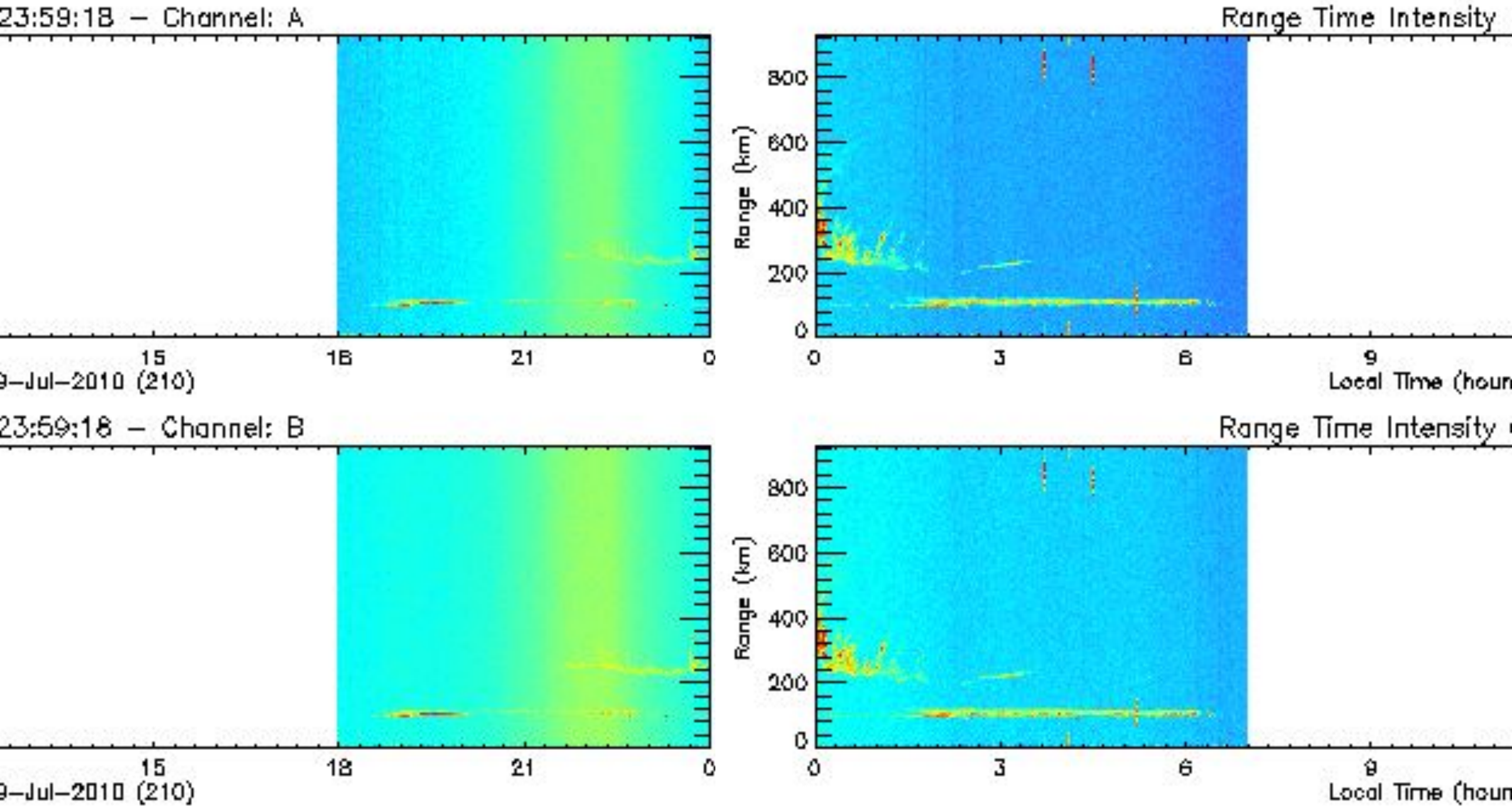
JULIA EW - ESF

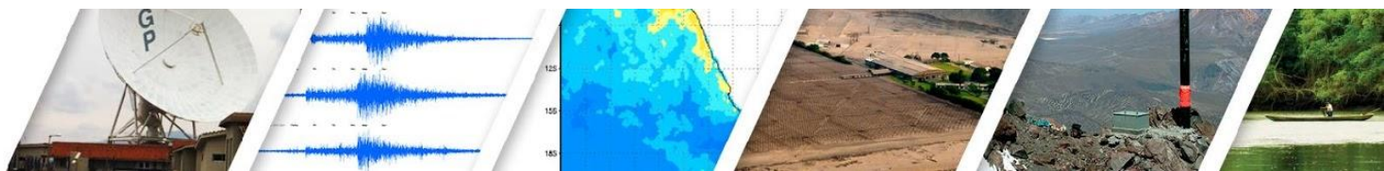
Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ

ower Maps – Date: 29–Jul–2010

Nation

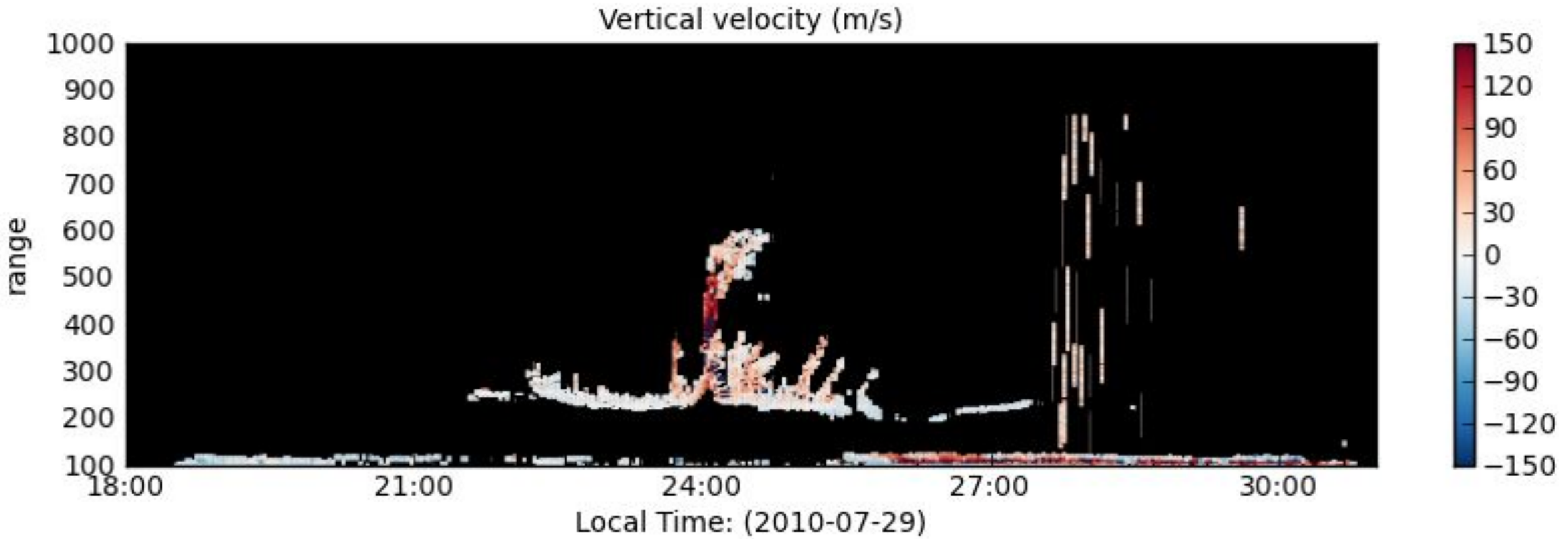


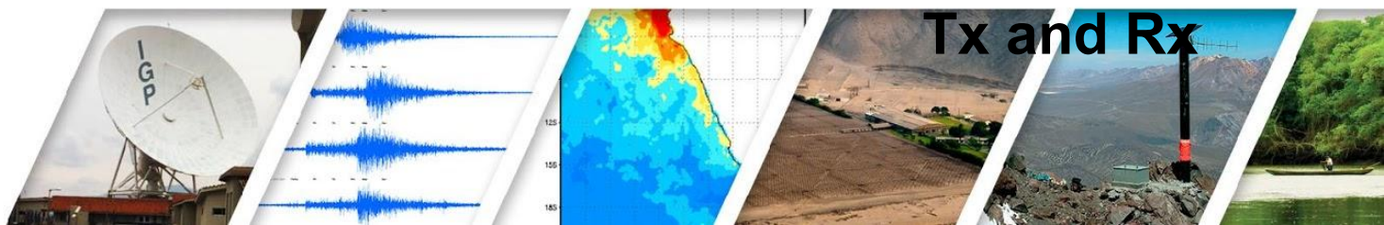


JULIA EW - ESF

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ

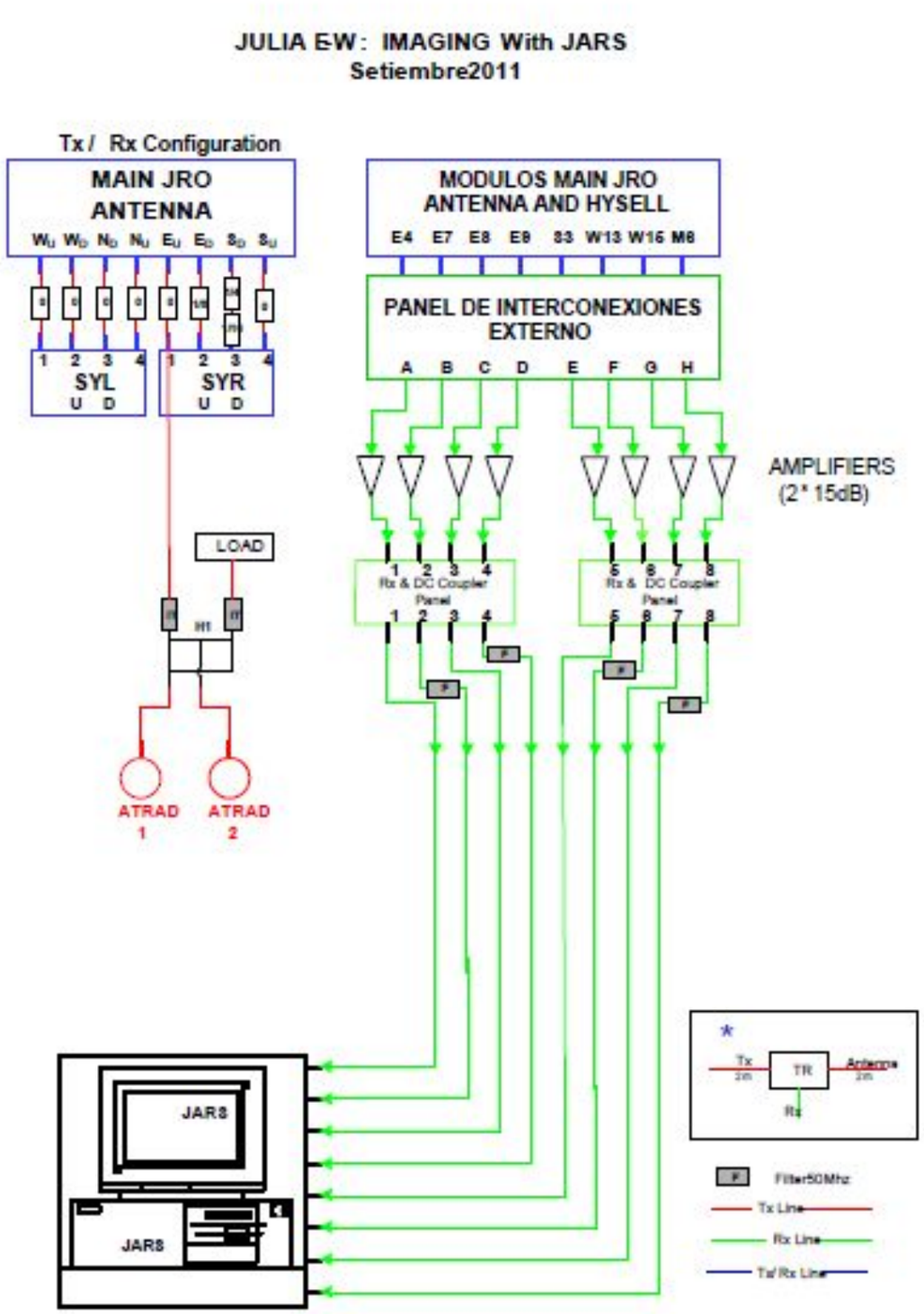




JULIA EW - IMAGING

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

IGP
INSTITUTO GEOFÍSICO DEL PERÚ



New JULIA EW & Imaging
J. Chau
K. Kuyeng/F. Galindo/M.Urco
October 2009

North Quarter

4/5	4/4	4/2	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

East Quarter

5/3	4/2	2/4	A X/3
4/4	3/3	B X/5	C X/4
D X/4	3/3	3/5	2/4
5/5	2/4	2/2	2/5

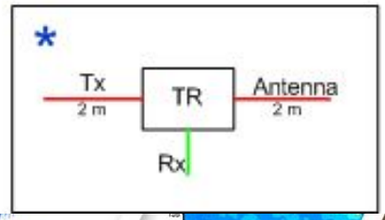
West Quarter

X/3	X/2	X/4	X/3
X/4	X/3	X/5	X/4
X/4	X/3	X/5	X/4
F X/5	X/4	G X/2	X/5

South Quarter

4/5	4/4	E 4/2*	4/5
3/2	3/5	3/3	3/2
2/2	2/5	2/3	2/2
5/3	5/2	5/4	5/3

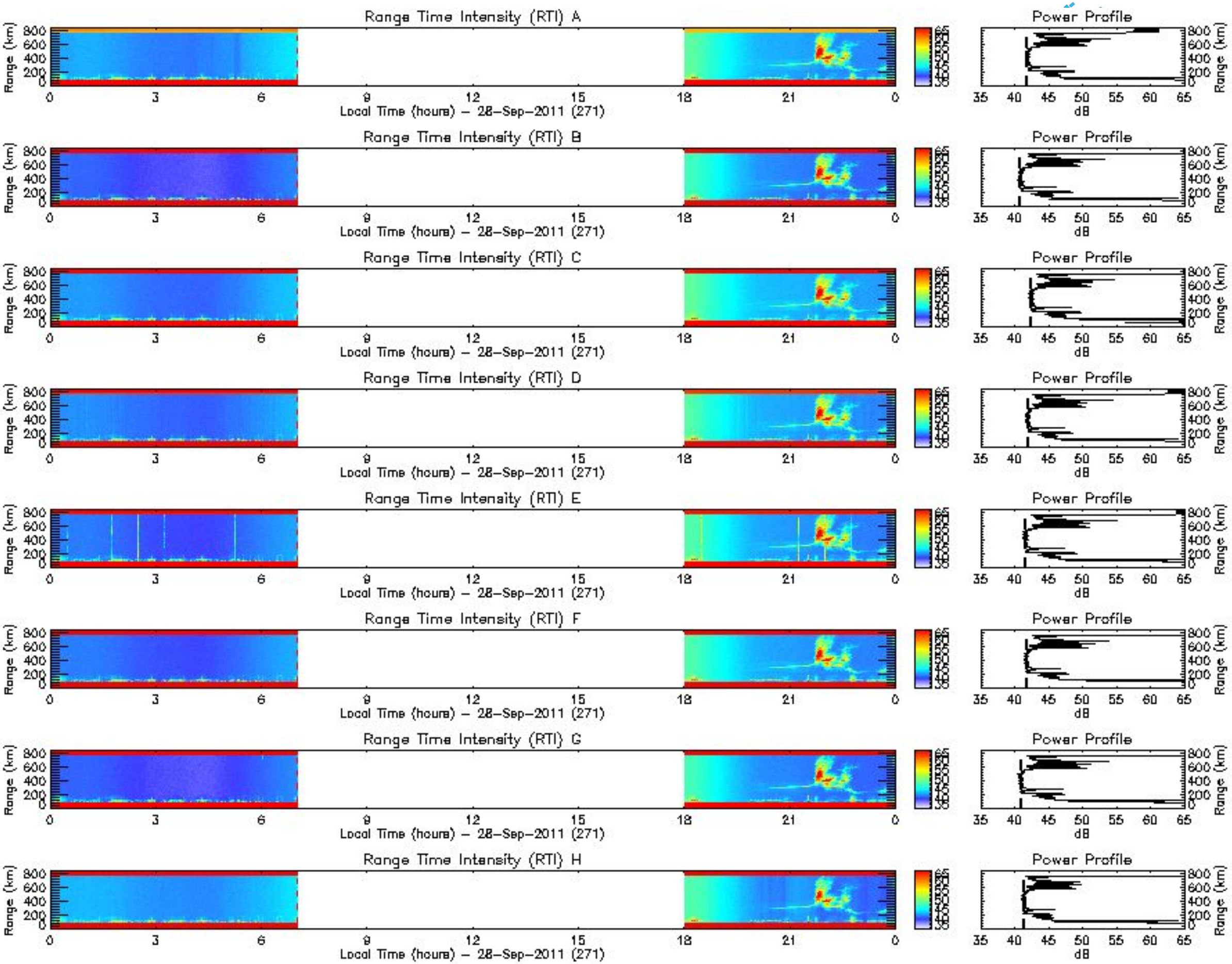
H Hysell module



Imaging modules (Up polarization)

Tx (Up)

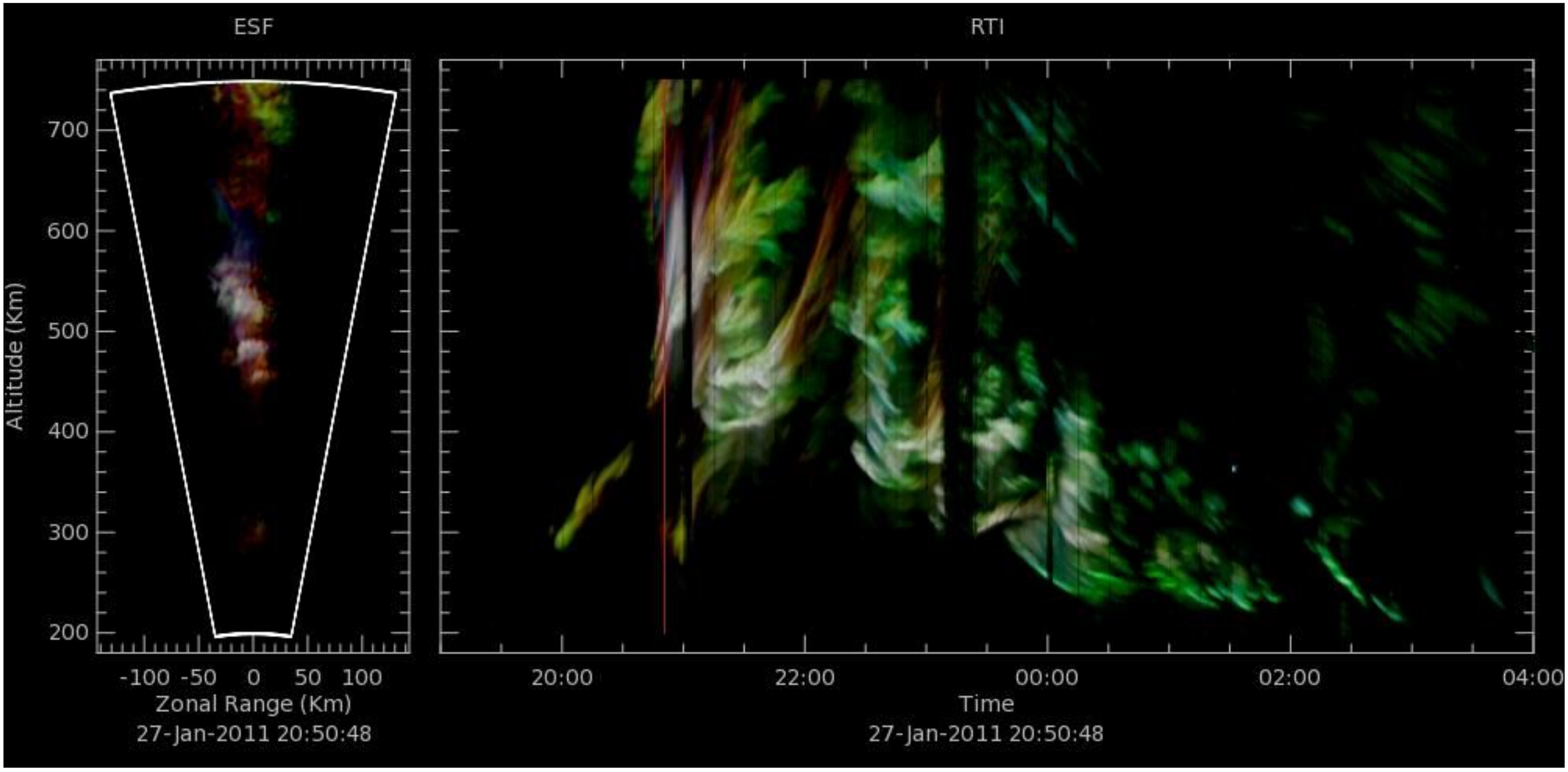
Rx (Up)

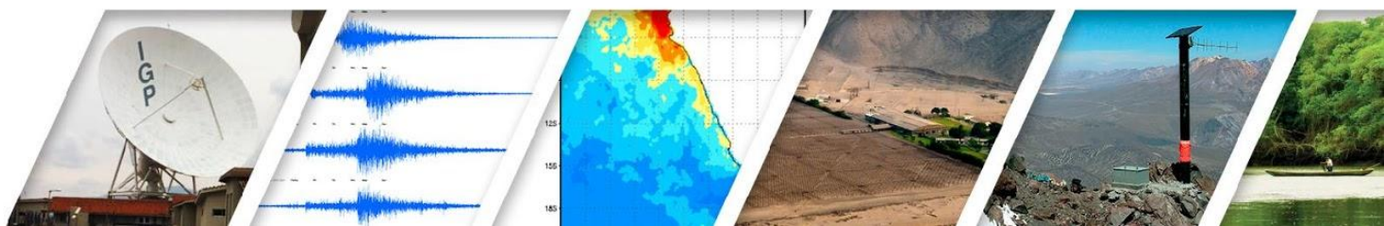

Range Time Intensity (RTI) A
Power Profile
Range Time Intensity (RTI) B
Power Profile
Range Time Intensity (RTI) C
Power Profile
Range Time Intensity (RTI) D
Power Profile
Range Time Intensity (RTI) E
Power Profile
Range Time Intensity (RTI) F
Power Profile
Range Time Intensity (RTI) G
Power Profile
Range Time Intensity (RTI) H
Power Profile
Range (km)
Local Time (hours) – 28–Sep–2011 (271)
dB

JULIA EW - IMAGING

Jicamarca Unattended Long-term Investigations of the Ionosphere and Atmosphere

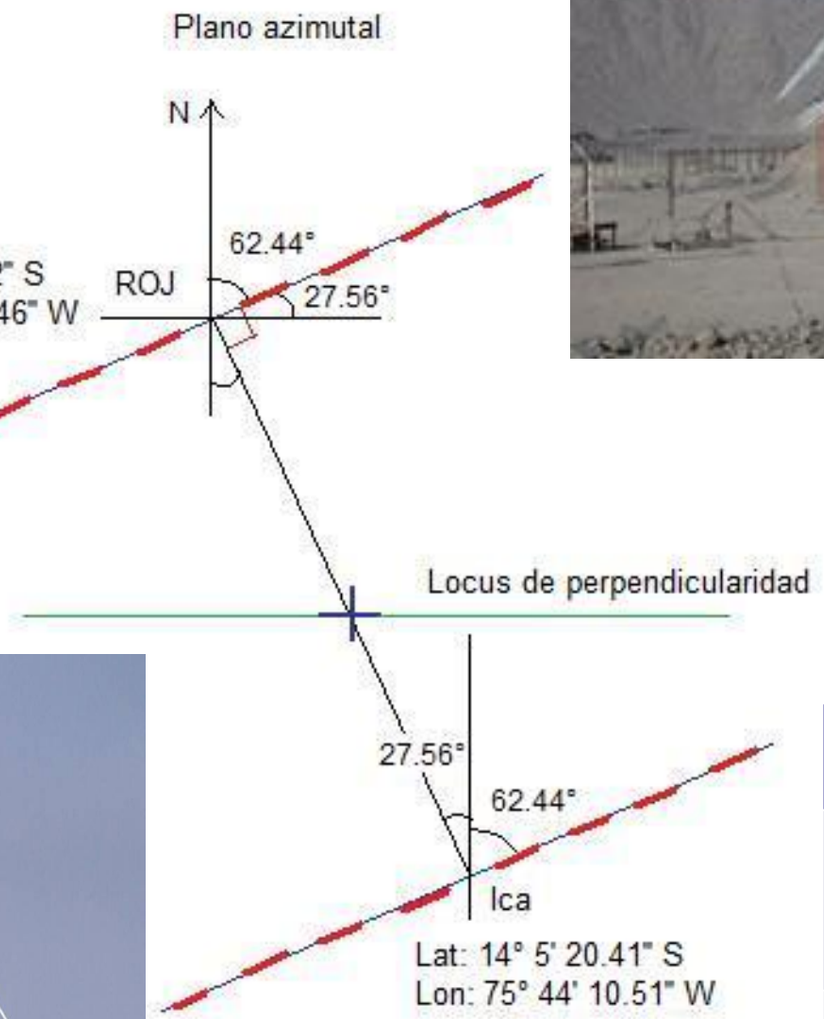
INSTITUTO GEOFÍSICO DEL PERÚ





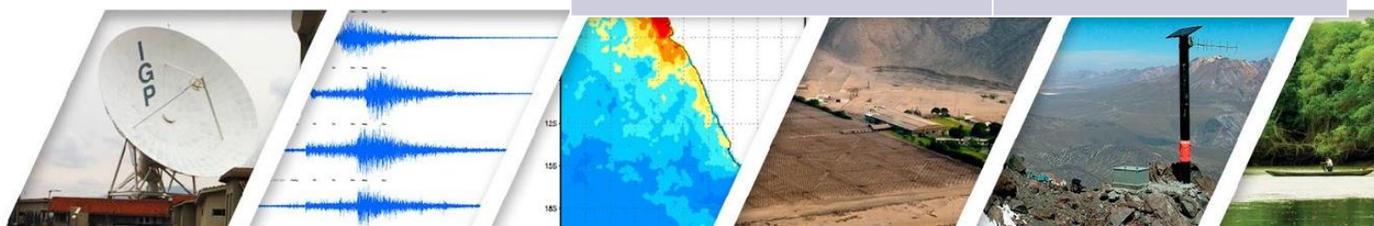
JULIA EW - BISTATIC

Transmit: JRO

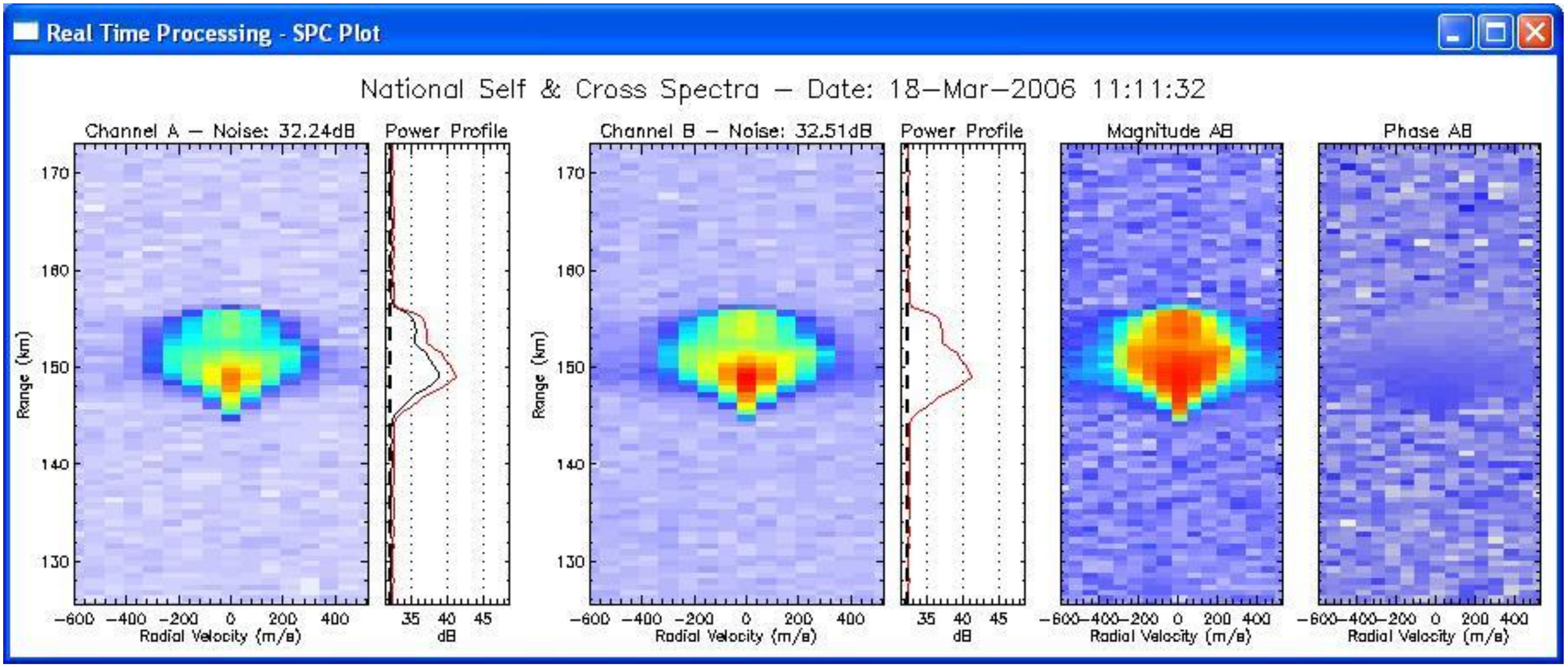


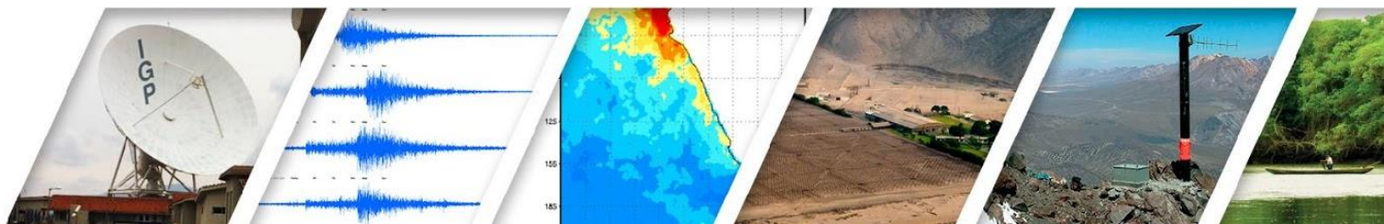
Receiver: ESI (Ica)

Param.	Valor
Frequency	49.92MHz
#Antennas	16 x 2
synch	PPS (GPS)

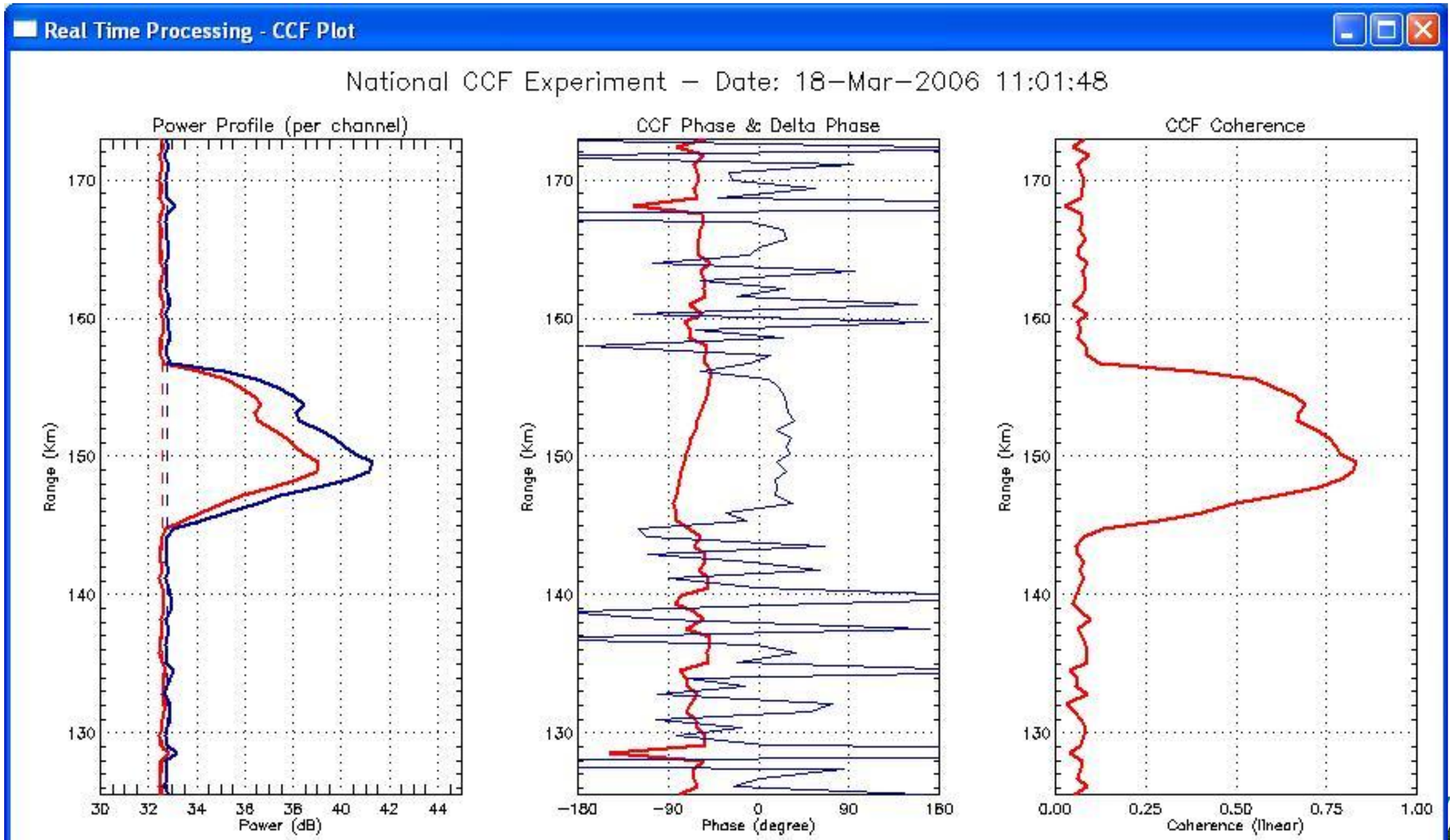


JULIA EW - BISTATIC

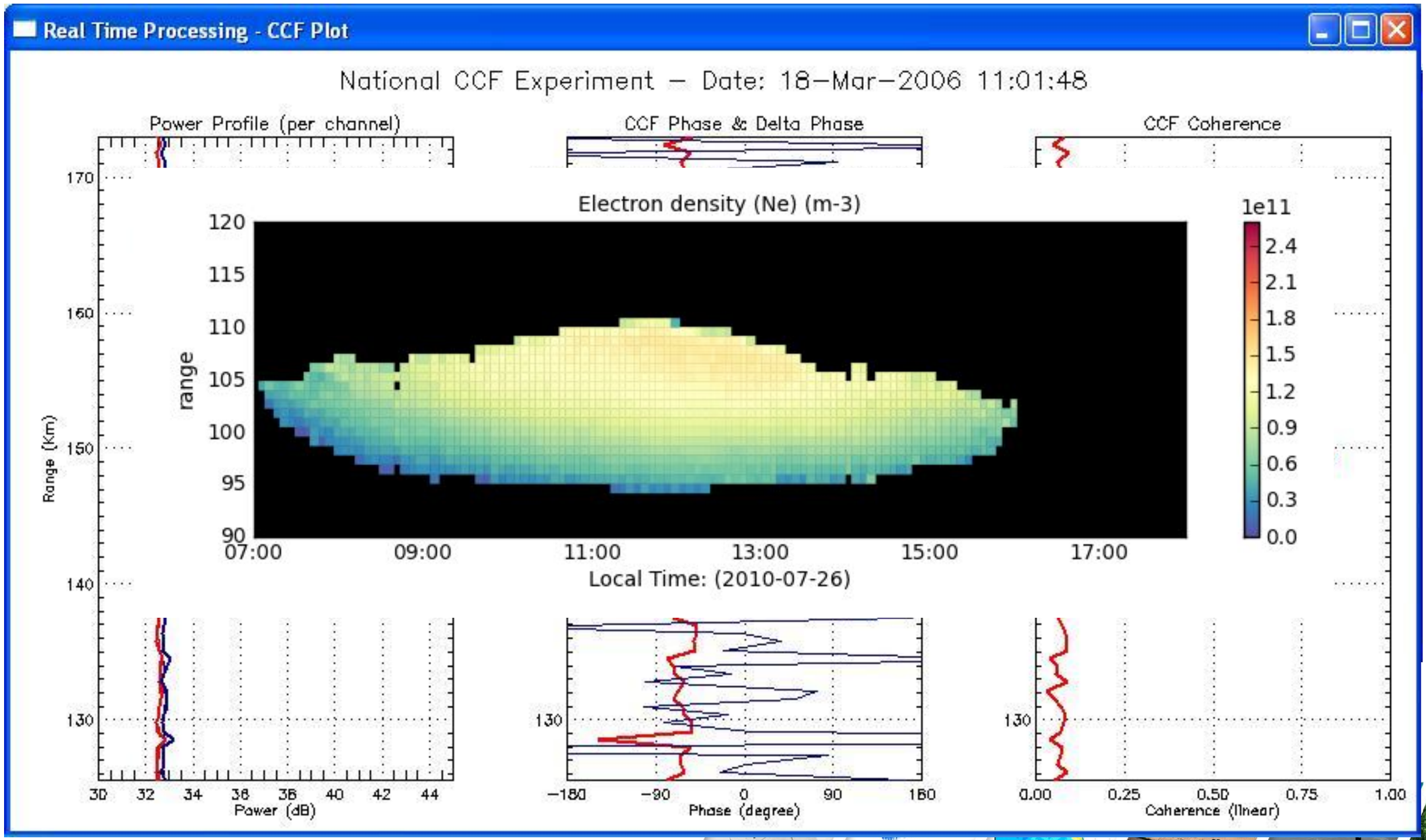




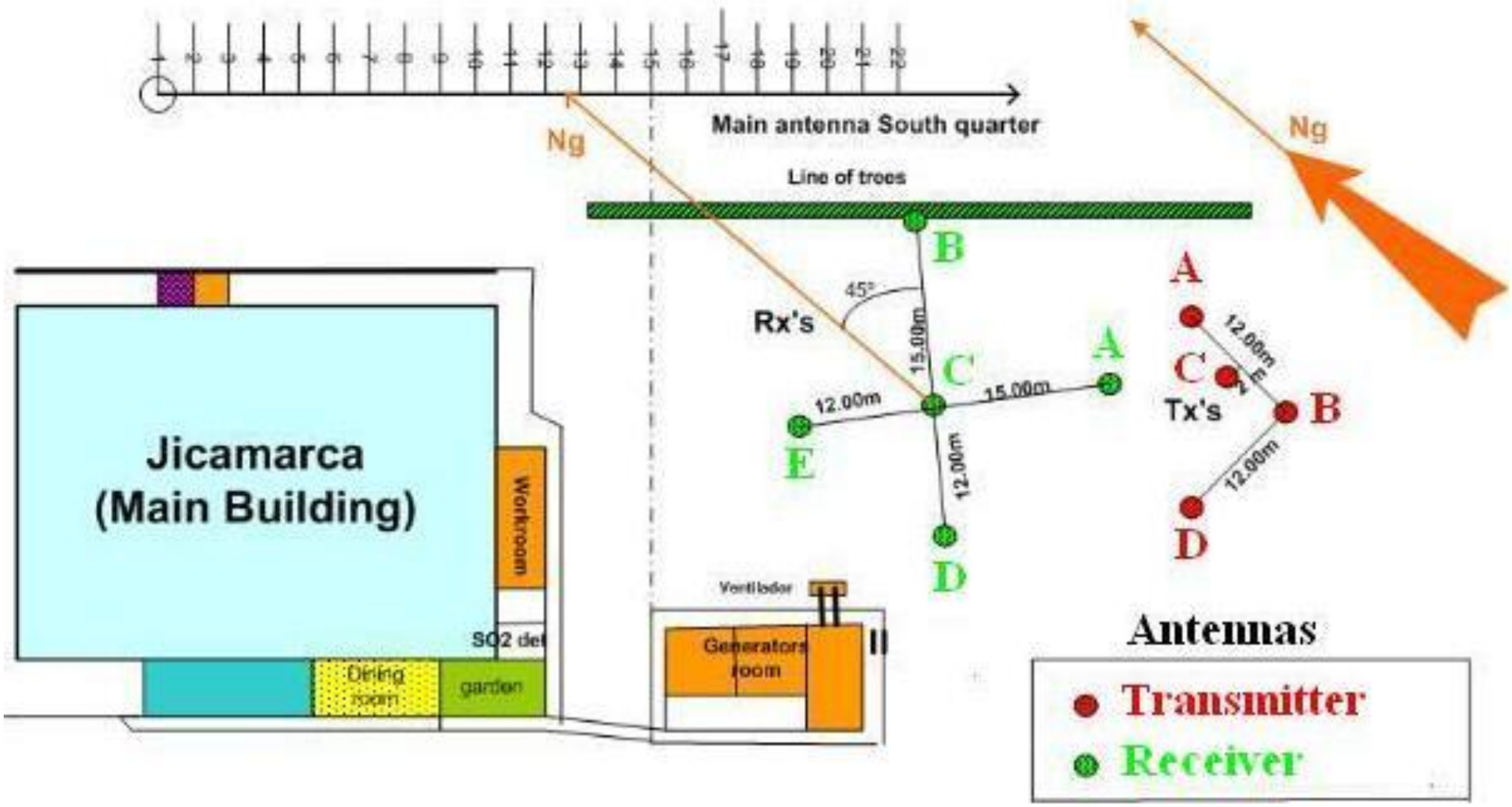
JULIA EW - BISTATIC

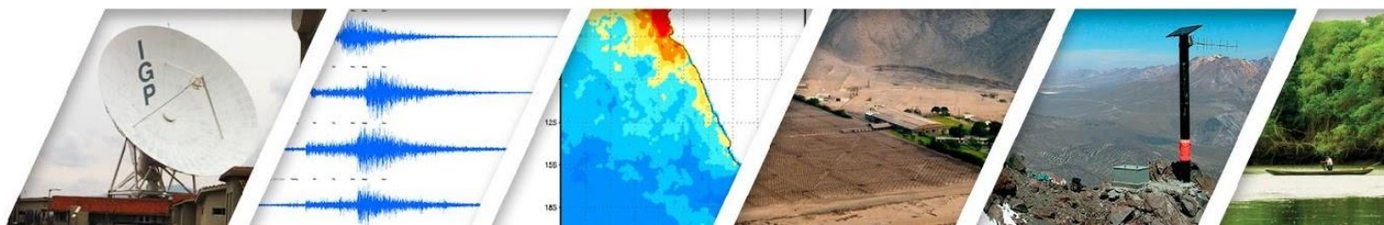


JULIA EW - BISTATIC



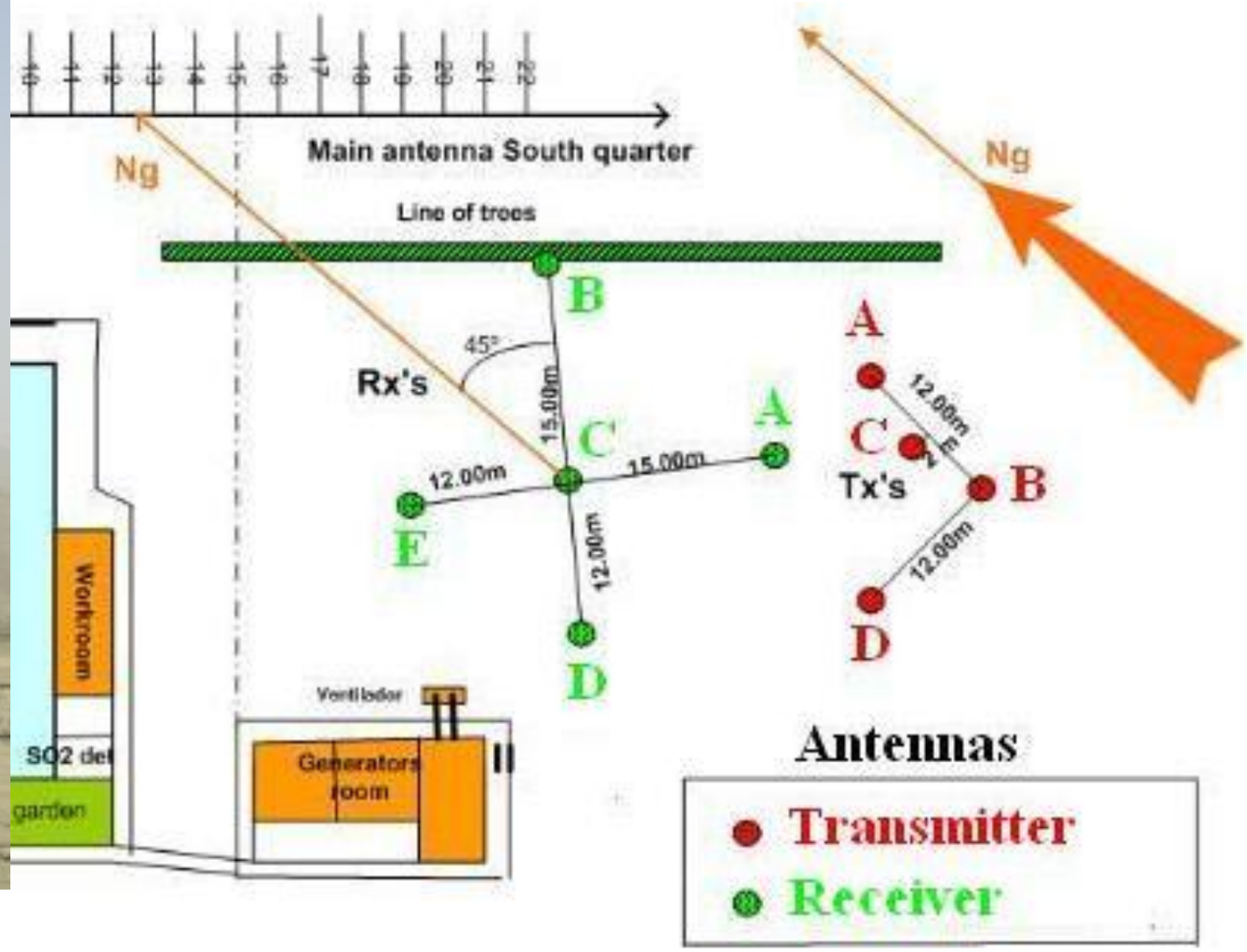
JASMET

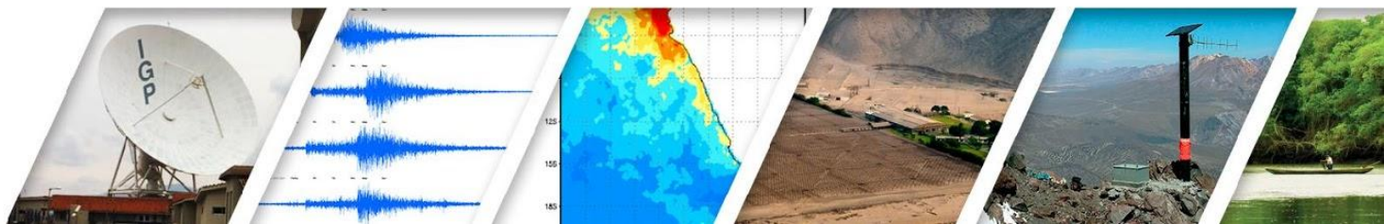

Main antenna South quarter
Ng
Line of trees
Ng
B
45°
Rx's
15.00m
C
A
12.00m
15.00m
E
12.00m
D
A
C
Tx's
B
12.00m
D
Jicamarca
(Main Building)
Workroom
SO2 de
Dining room
garden
Ventilador
Generators room
Antennas
Transmitter
Receiver


IGP

JASMET
Jicamarca All-sky Specular MEteor Radar

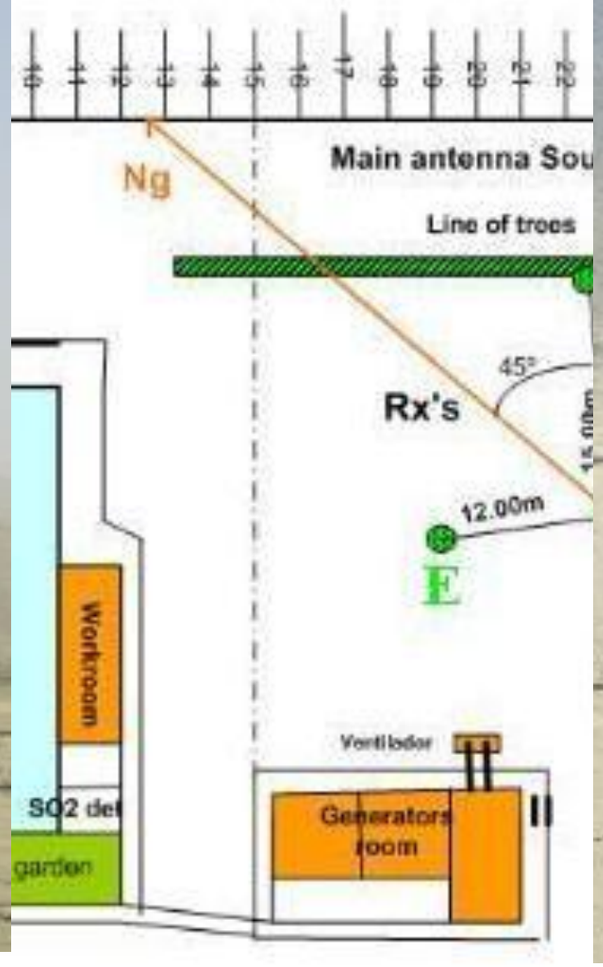
Tx Antenna



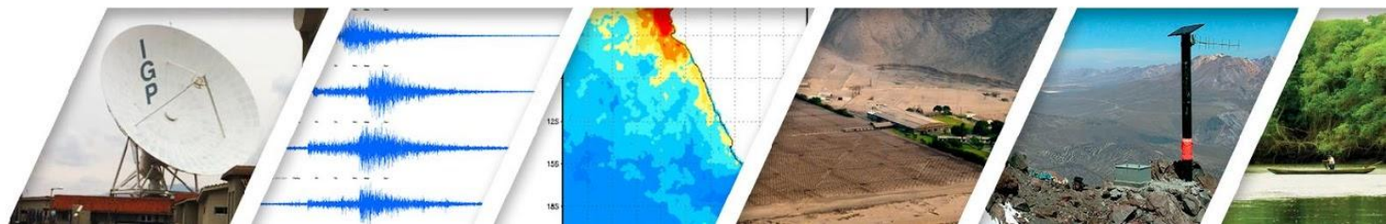


JASMET
Jicamarca All-sky Specular MEteor Radar

Tx Antenna



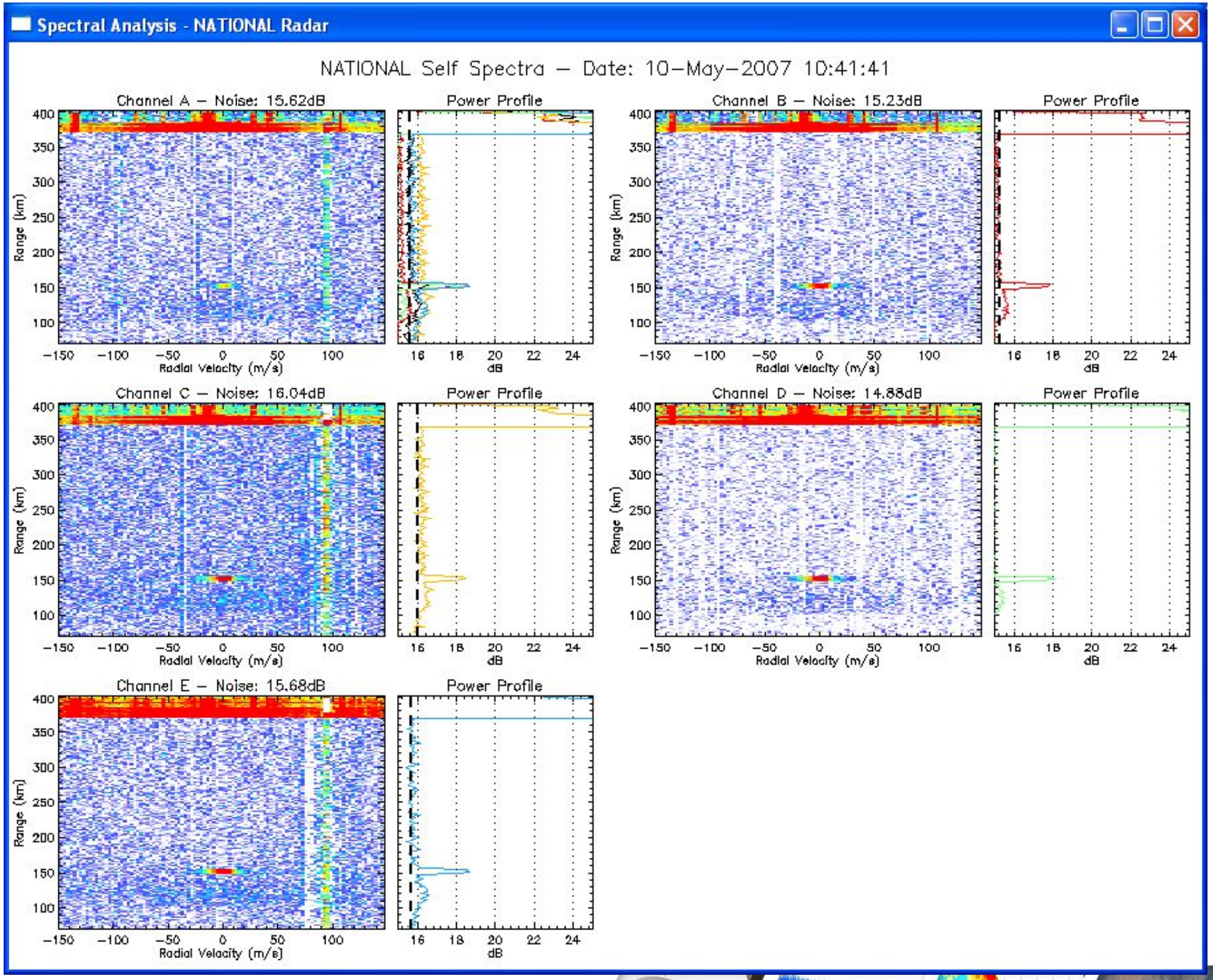
Rx Antenna

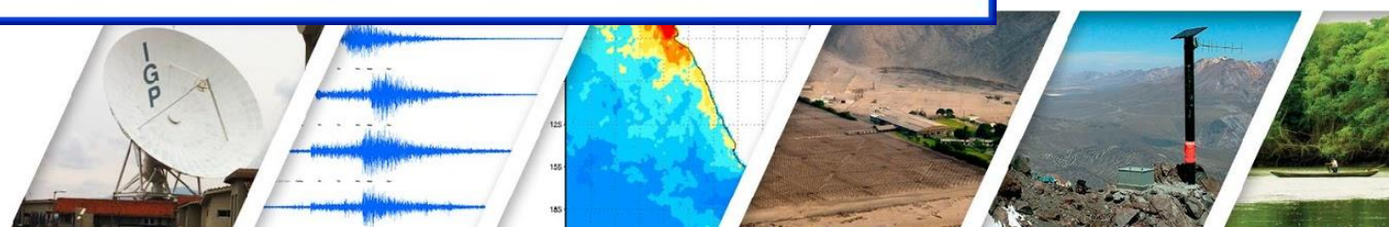


JASMET

Jicamarca All-sky Specular MEteor Radar

INSTITUTO GEOFÍSICO DEL PERÚ

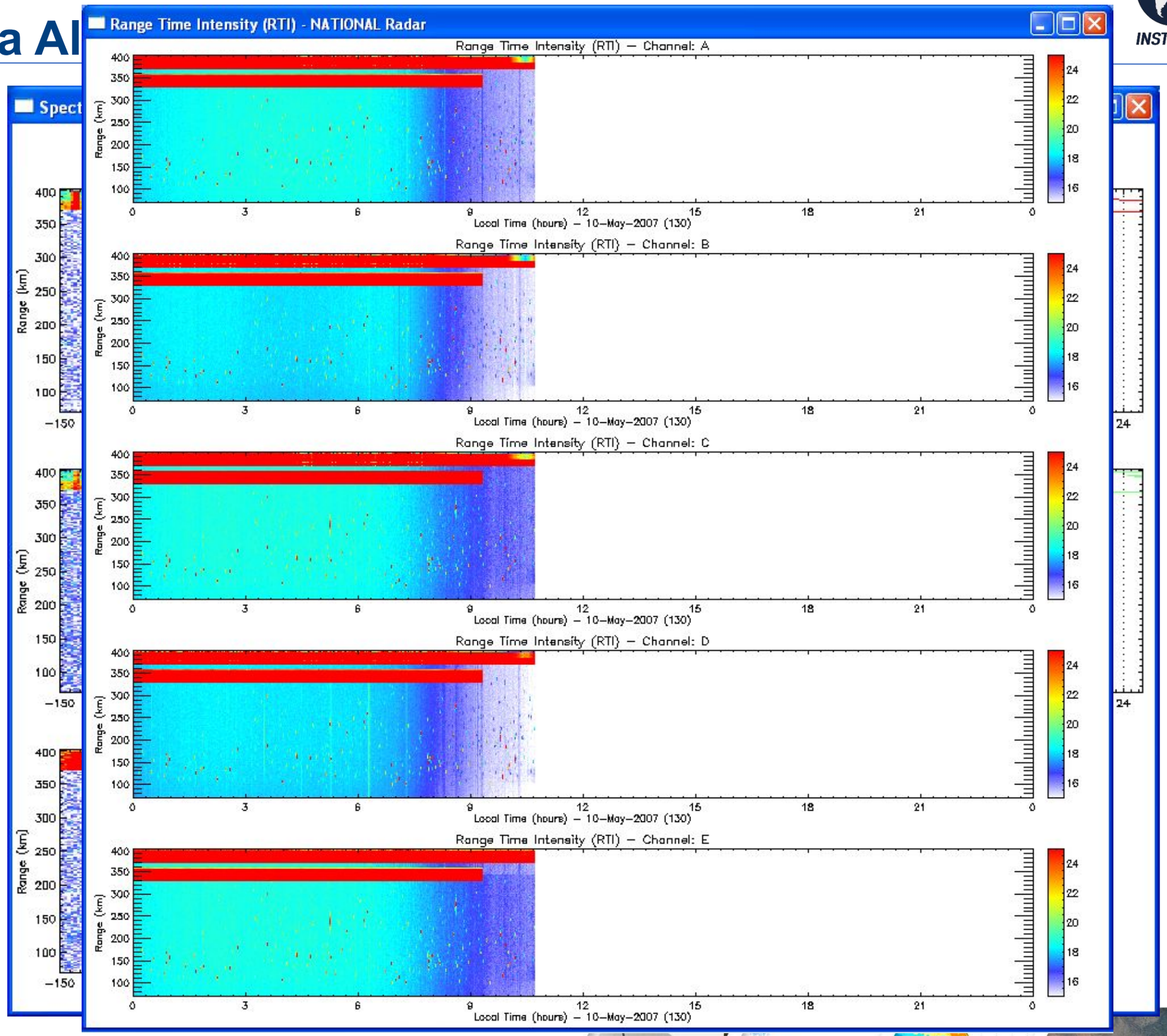


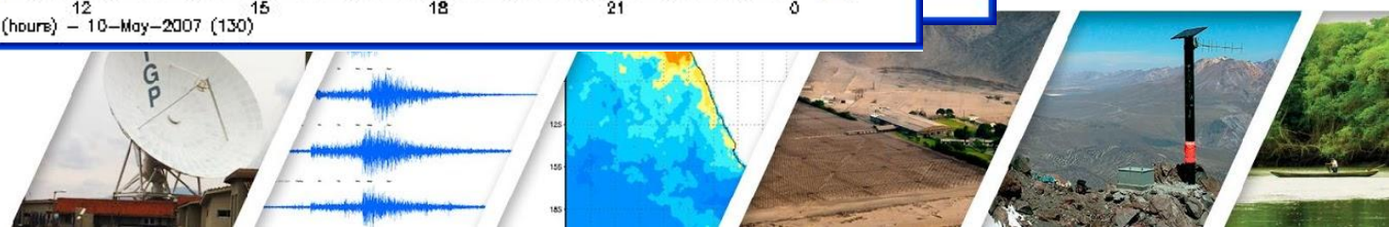


JASMET

Jicamarca Al

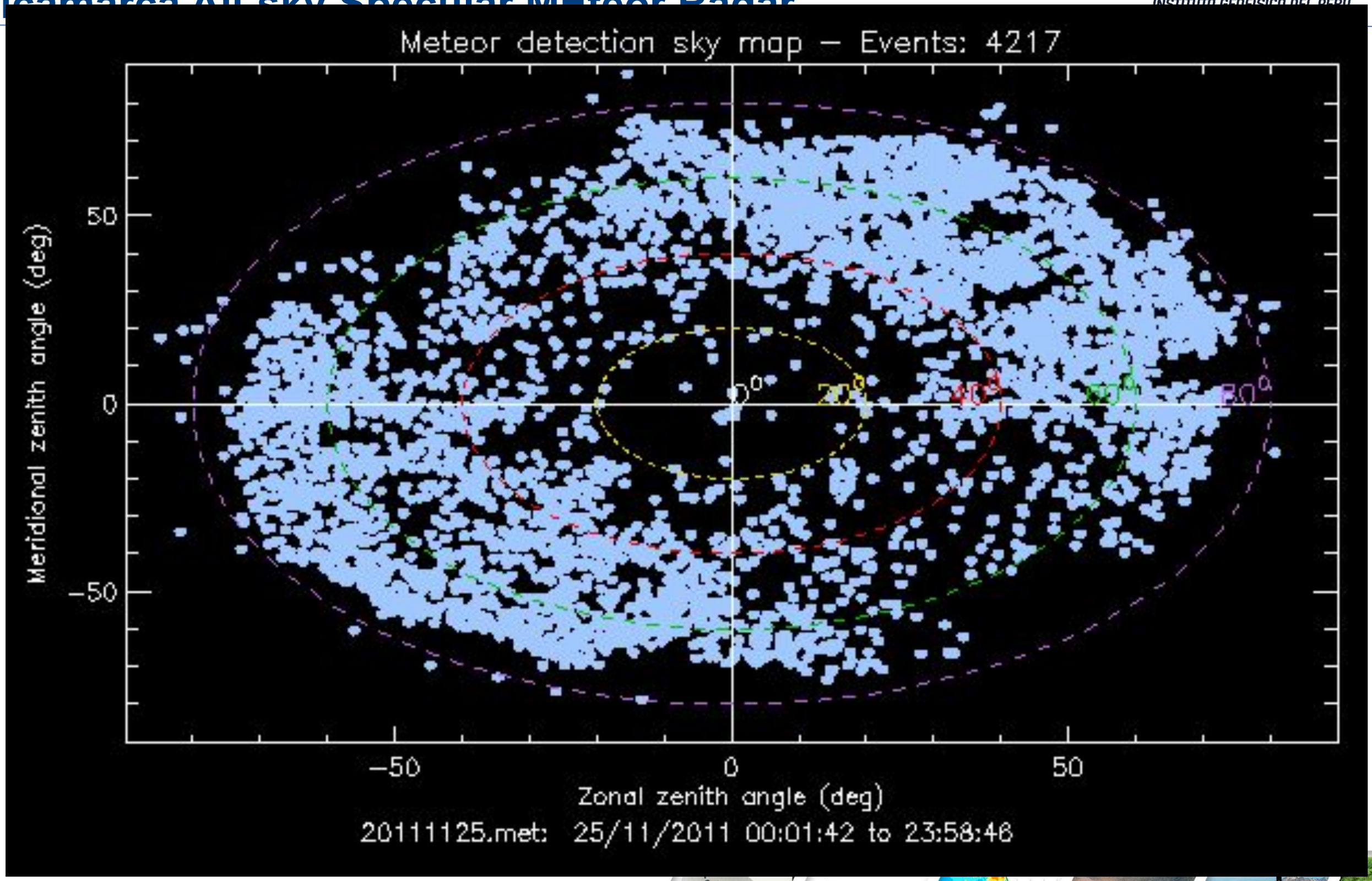
INSTITUTO GEOFÍSICO DEL PERÚ

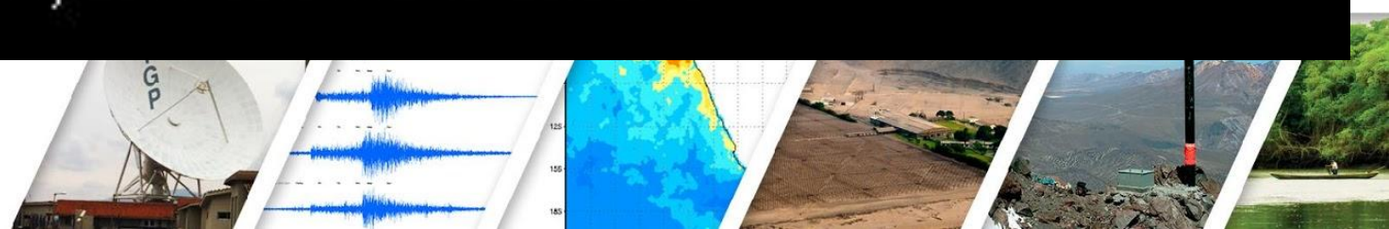




JASMET

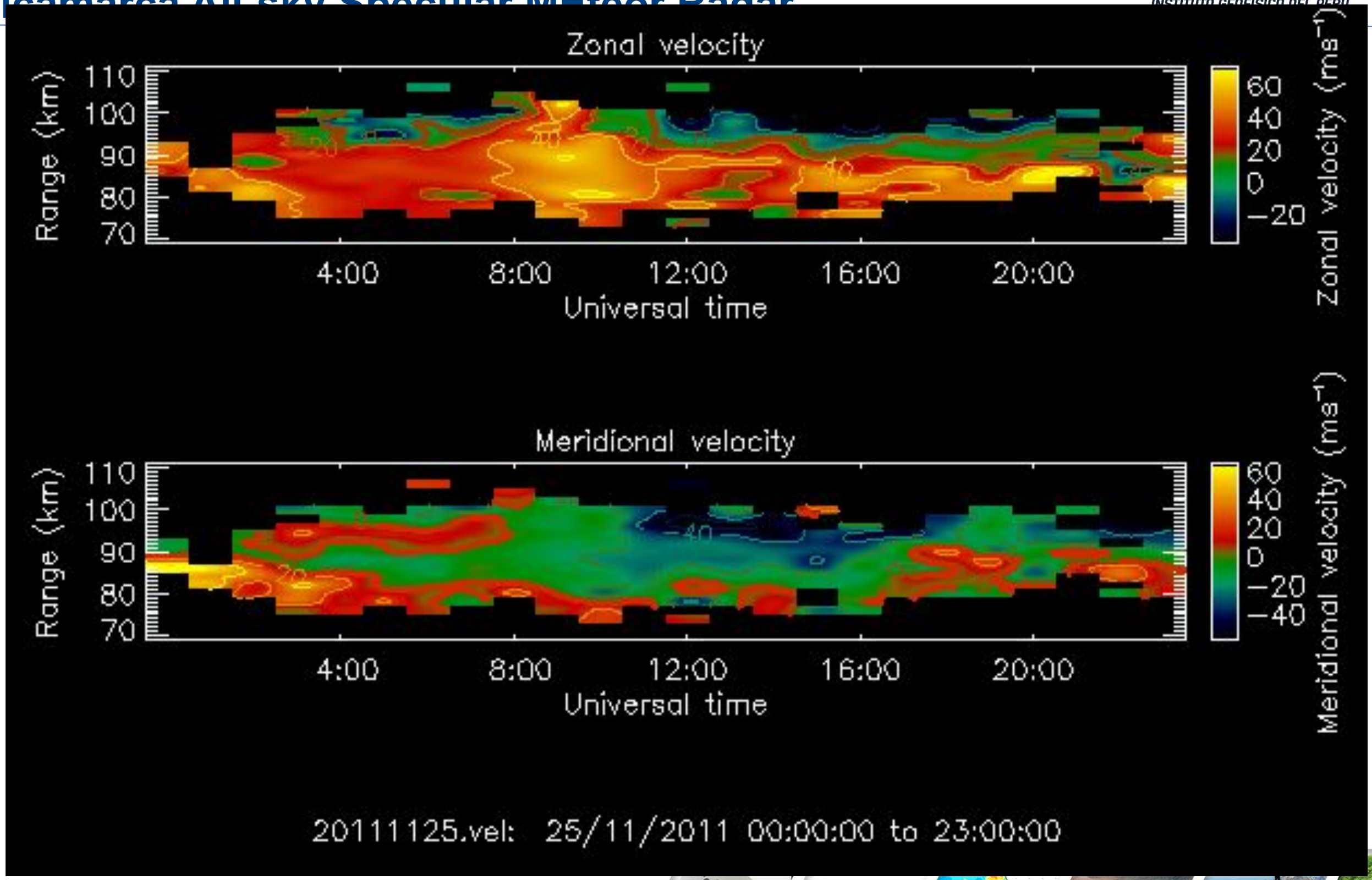
Jicamarca All-sky Specular MEteor Radar

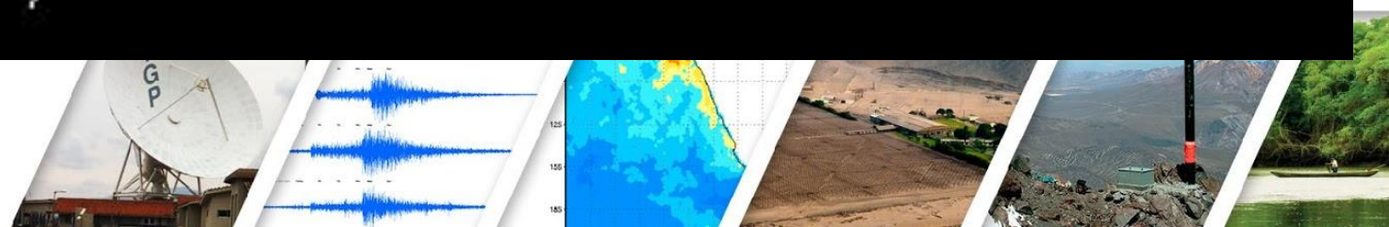




JASMET

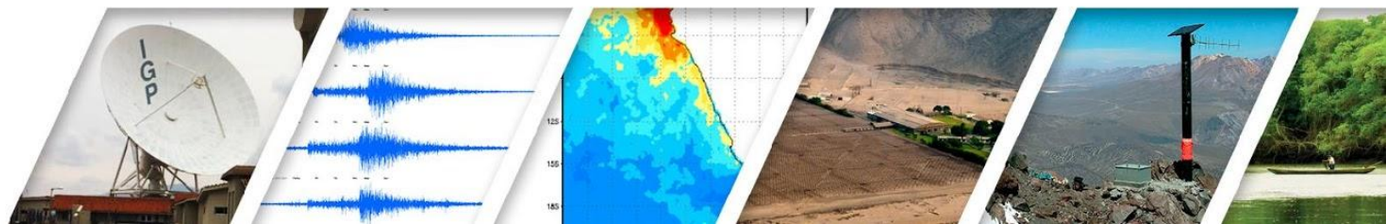
Jicamarca All-sky Specular MEteor Radar



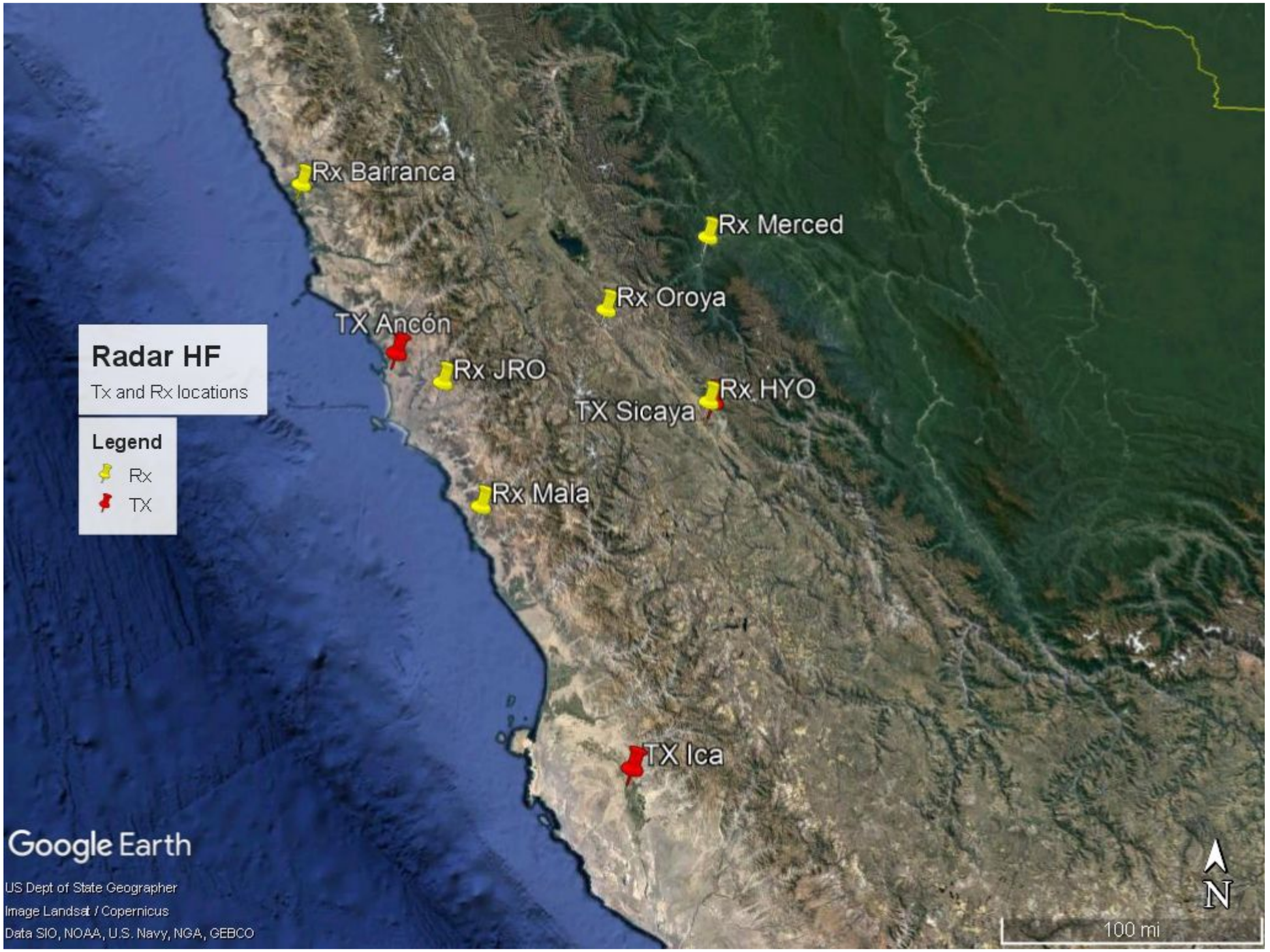


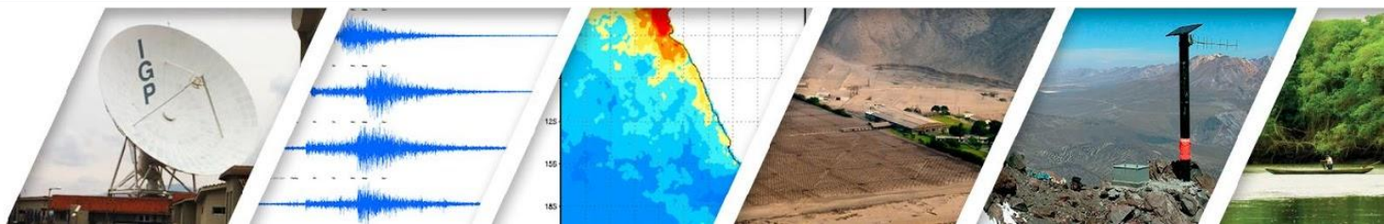
INSTITUTO GEOFÍSICO DEL PERÚ

REFLECTED SIGNALS

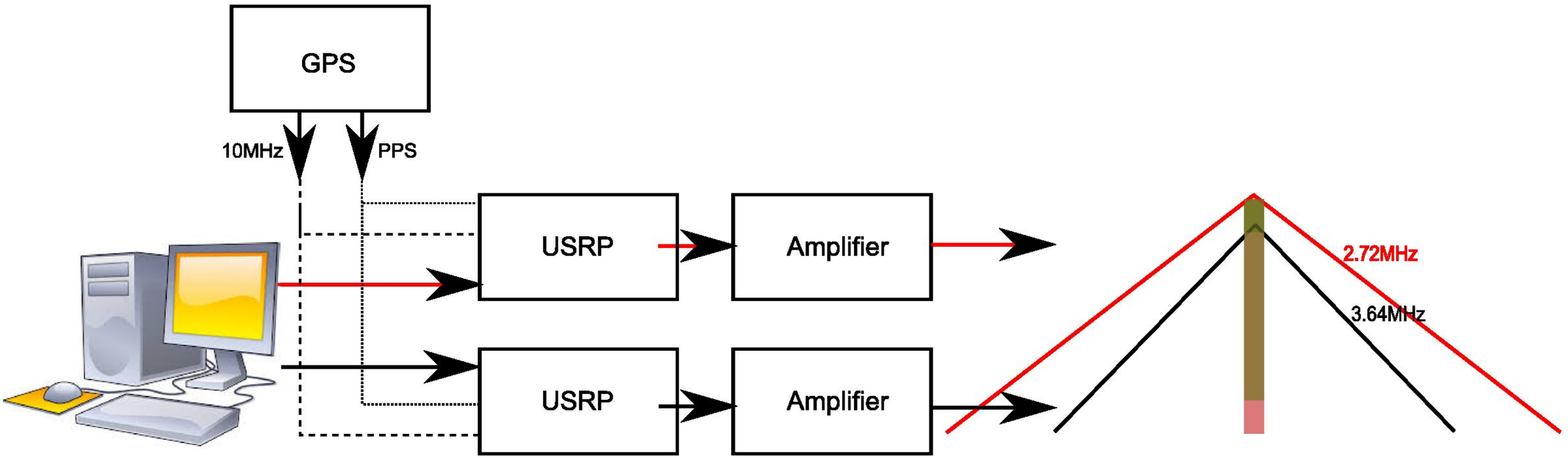


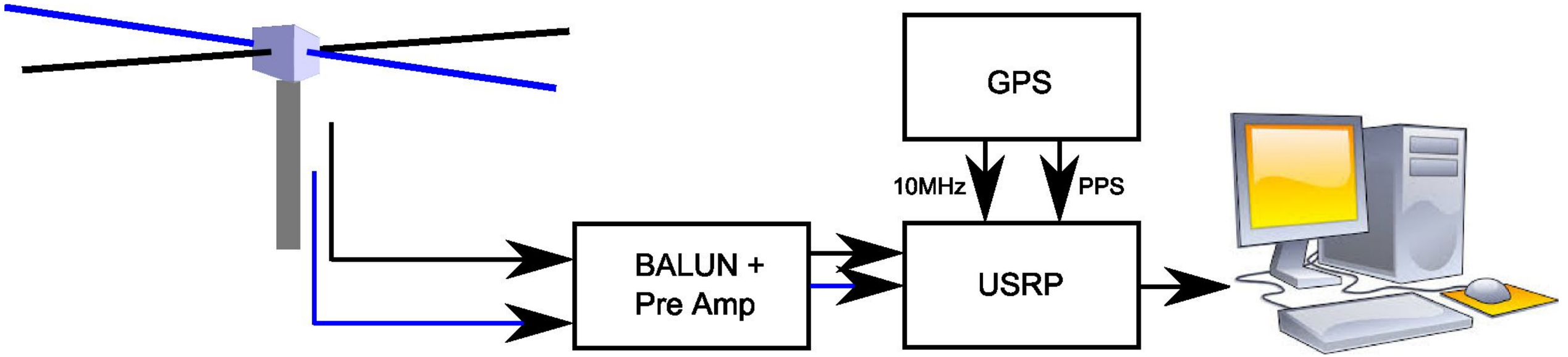
HF radar

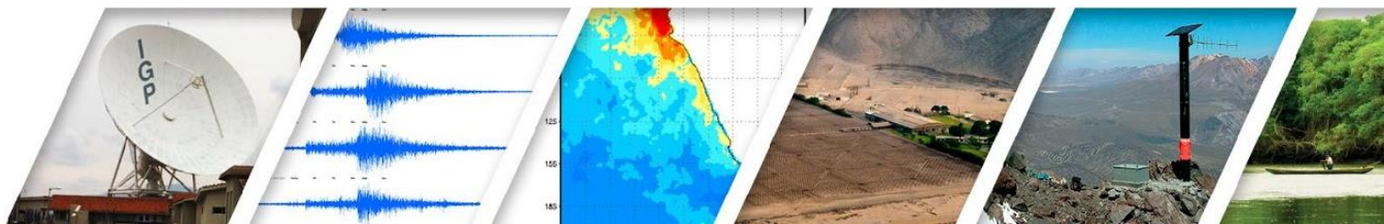

Rx Barranca
Rx Merced
Rx Oroya
TX Ancón
Rx JRO
Rx HYO
TX Sicaya
Rx Mala
TX Ica
Radar HF
Tx and Rx locations
Legend
Rx
TX
Google Earth
US Dept of State Geographer
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
100 mi


IGP

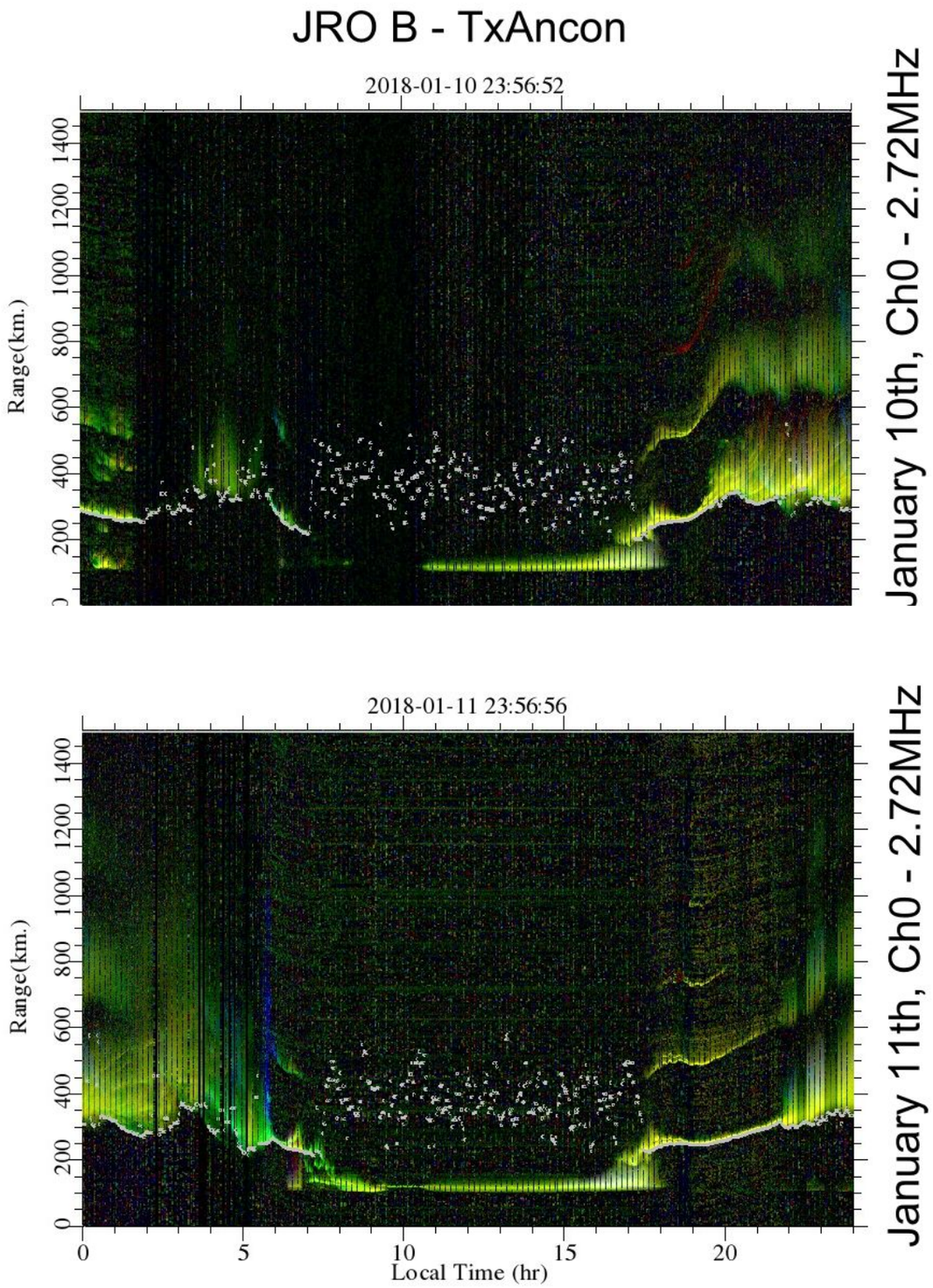
HF radar

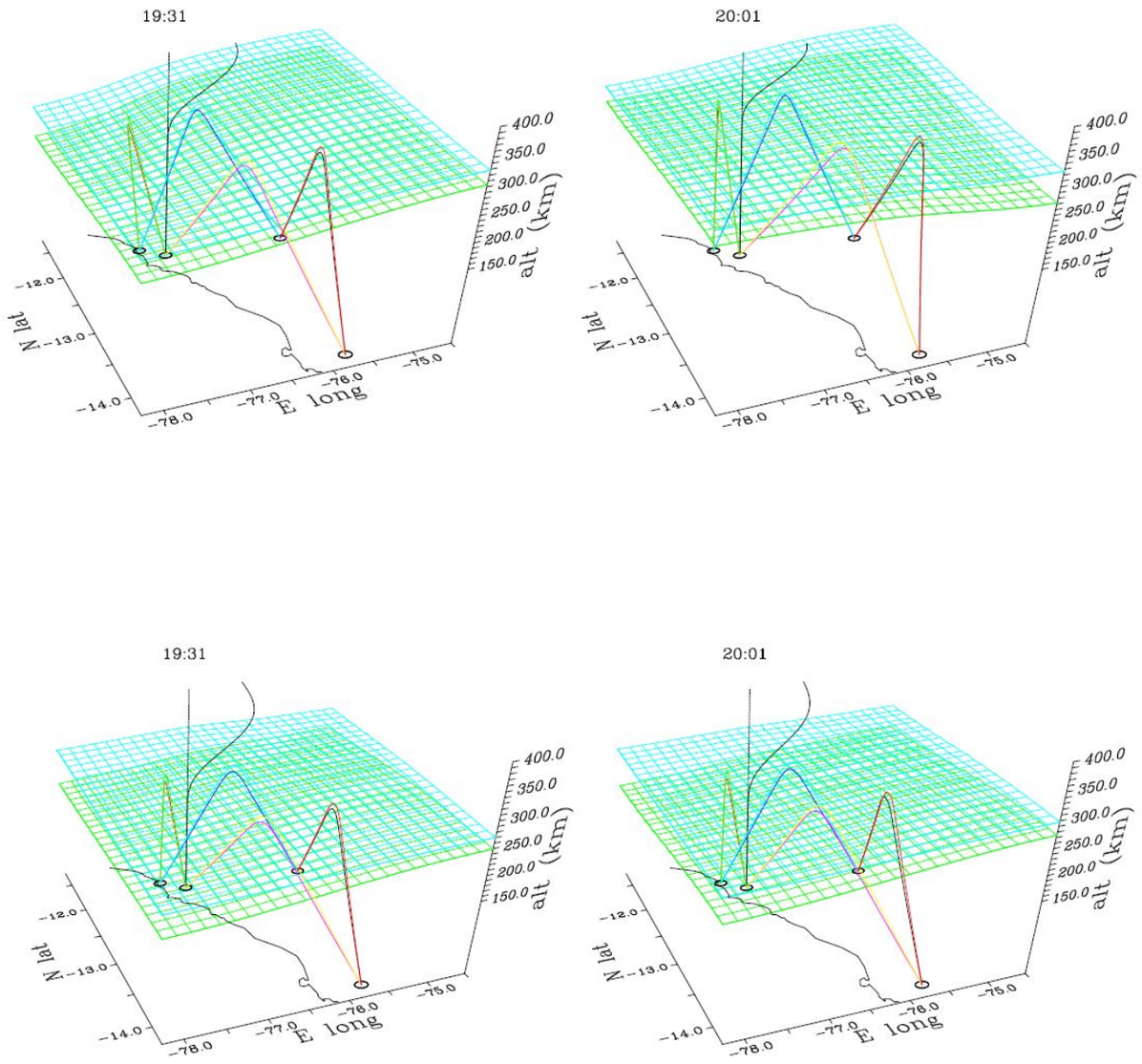

GPS
10MHz
PPS
USRP
Amplifier
USRP
Amplifier
2.72MHz
3.64MHz

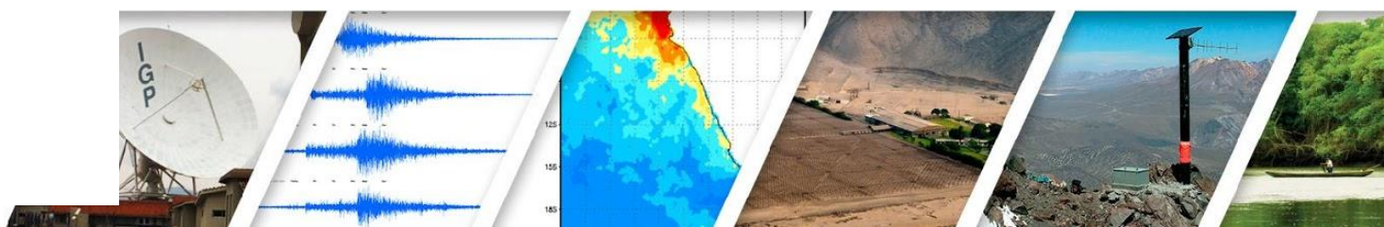

GPS
10MHz
PPS
BALUN +
Pre Amp
USRP


IGP

HF radar

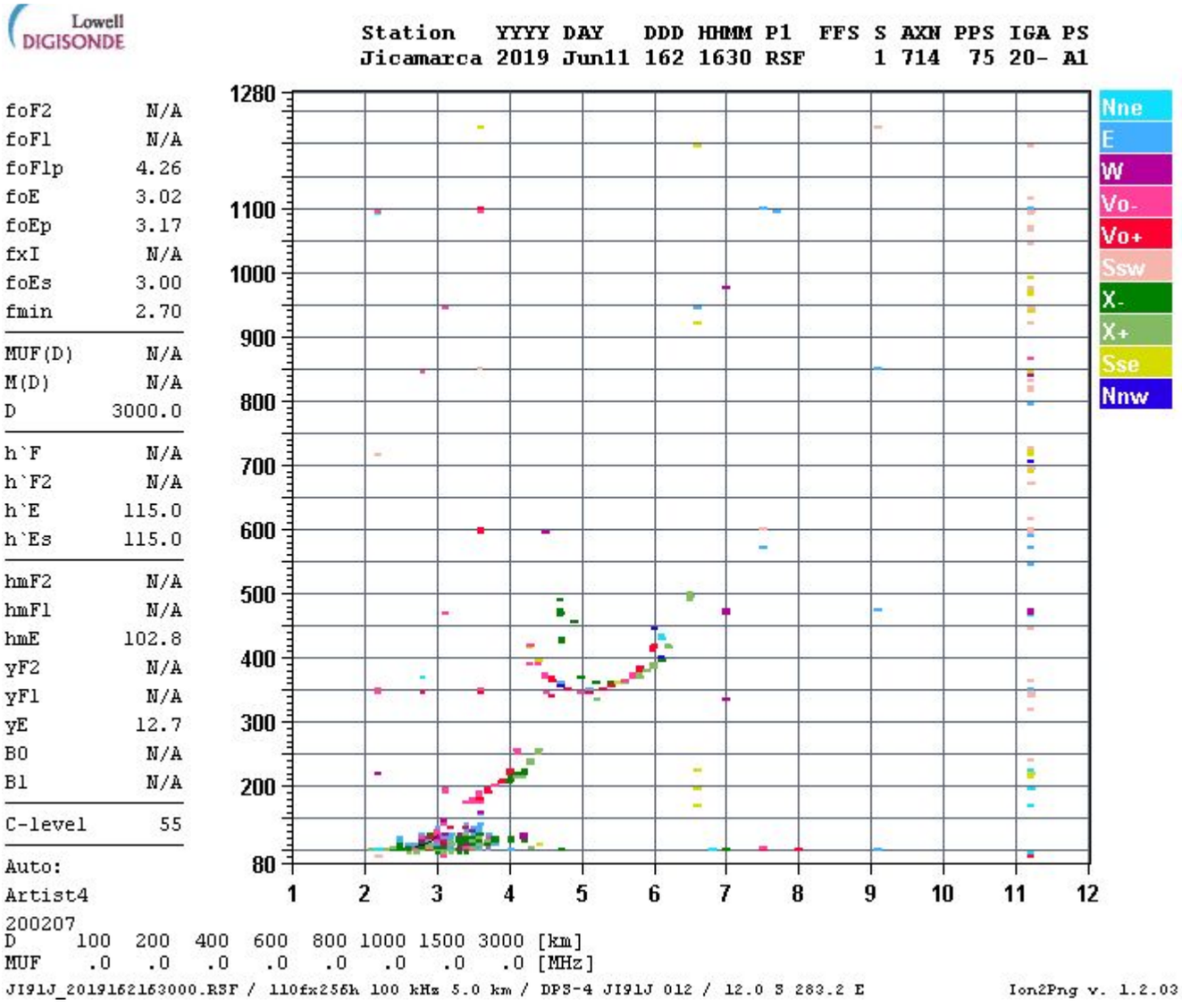

JRO B - TxAncon
2018-01-10 23:56:52
Range(km.)
0
200
400
600
800
1000
1200
1400
January 10th, Ch0 - 2.72MHz
2018-01-11 23:56:56
0
5
10
15
20
Local Time (hr)
January 11th, Ch0 - 2.72MHz

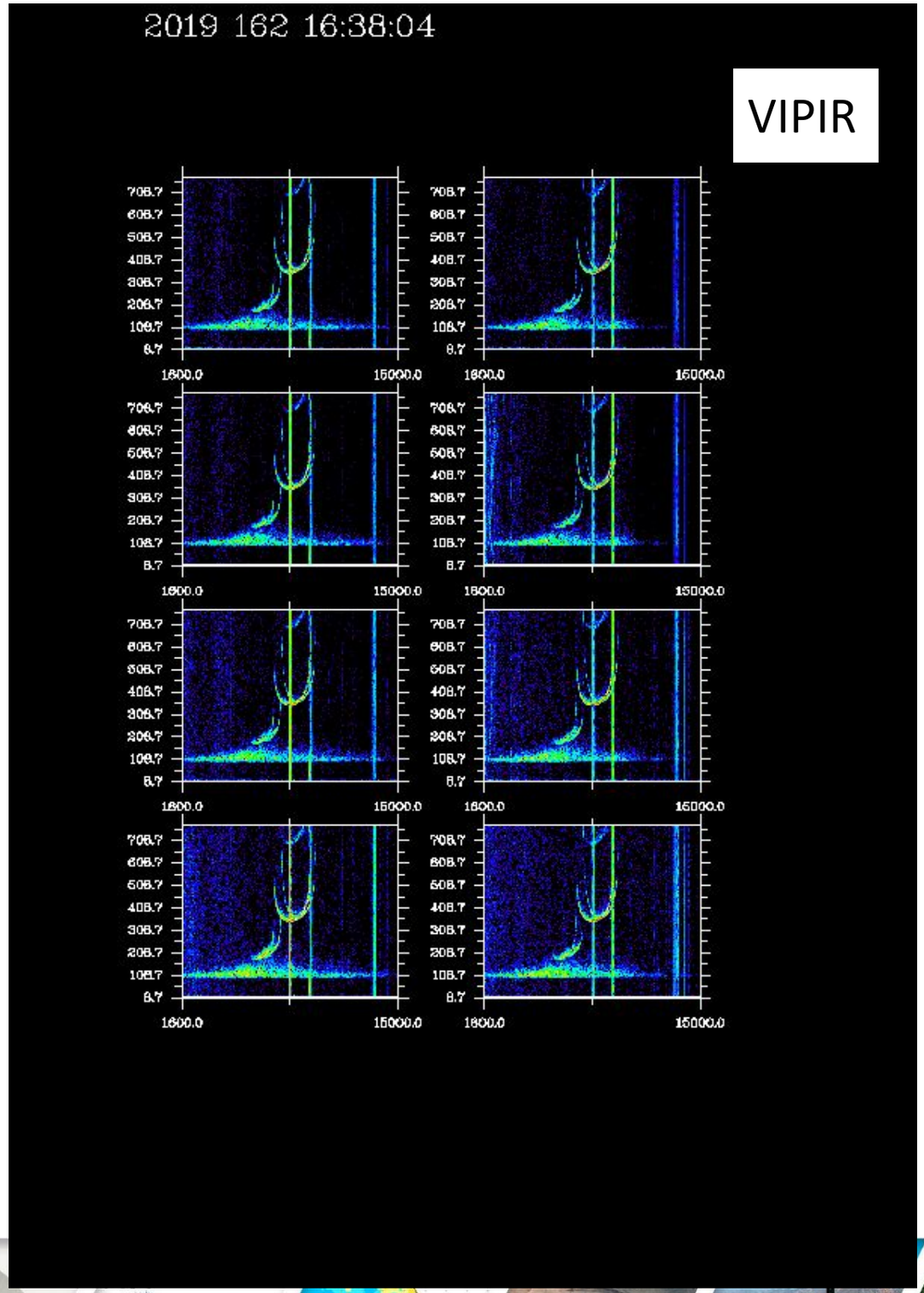

19:31
20:01
400.0
350.0
300.0
250.0
200.0
150.0
alt (km)
N lat
-12.0
-13.0
-14.0
-78.0
-77.0
-76.0
-75.0
E long

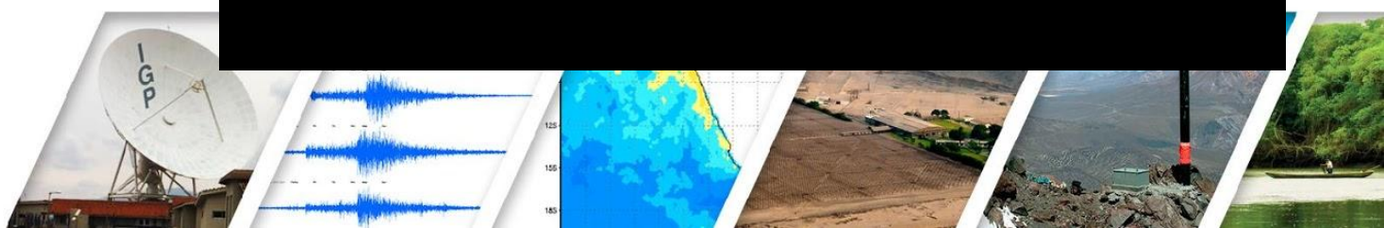

IGP

Ionosondes

Digisonde

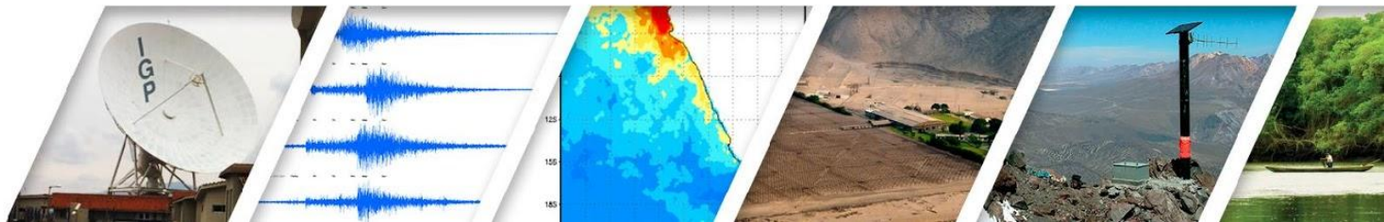






More radars

RADAR	OBJECTIVE	OPERATING FREQUENCY	LOCATION
CLAIRE	Precipitation turbulence and winds	445MHz	Huancayo (OHY)
BLTR	Boundary Layer and tropospheric studies	50MHz	Huancayo (OHY)
CIRI-PSU	Equatorial irregularities (EEJ +ESF)	~47MHz	Huancayo (OHY)
TIDDBIT	Ionsophere reflections	~4MHz and 5MHz	Tx:Lurin, Sayán, Matucana Rx:Ancón



IGP
INSTITUTO GEOFÍSICO DEL PERÚ

Ciencia para protegernos, ciencia para avanzar.

www.igp.gob.pe