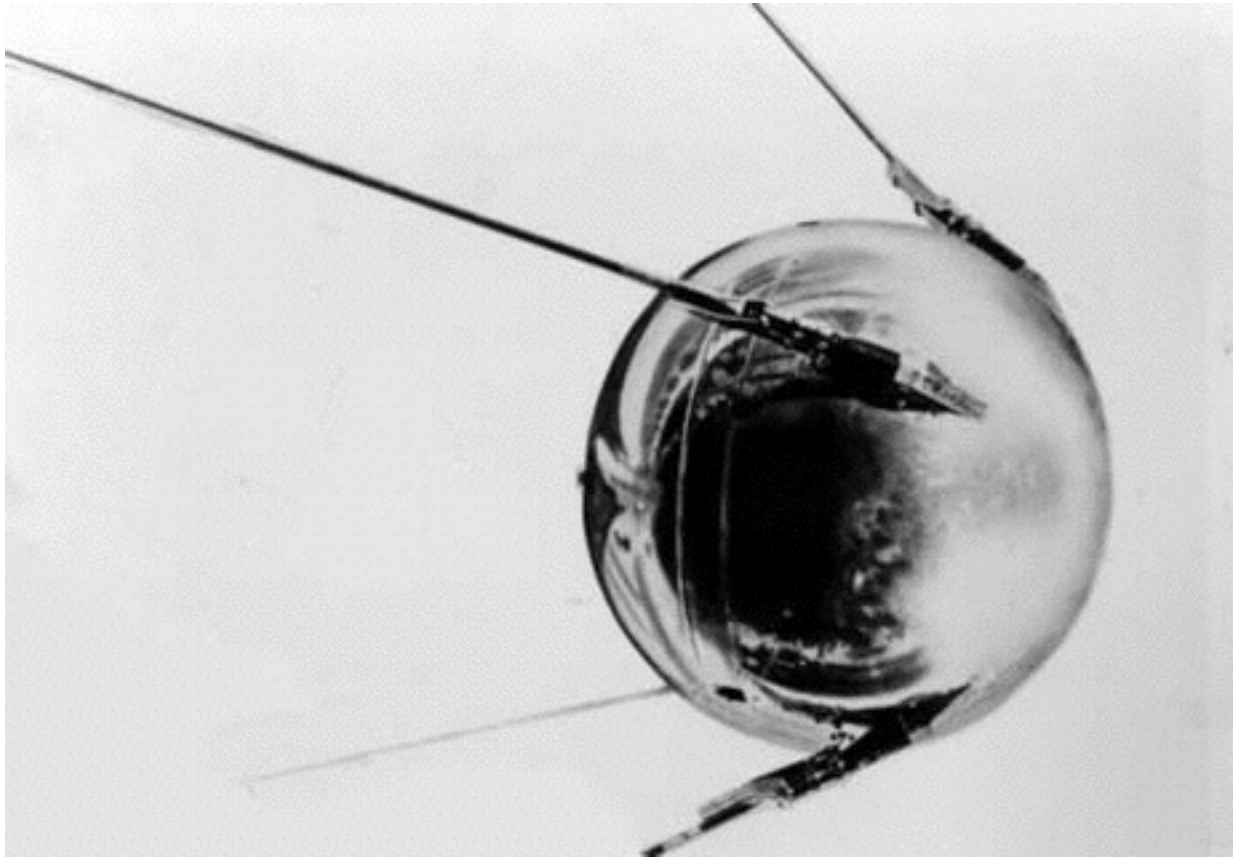
Early History of the Jicamarca Radio Observatory

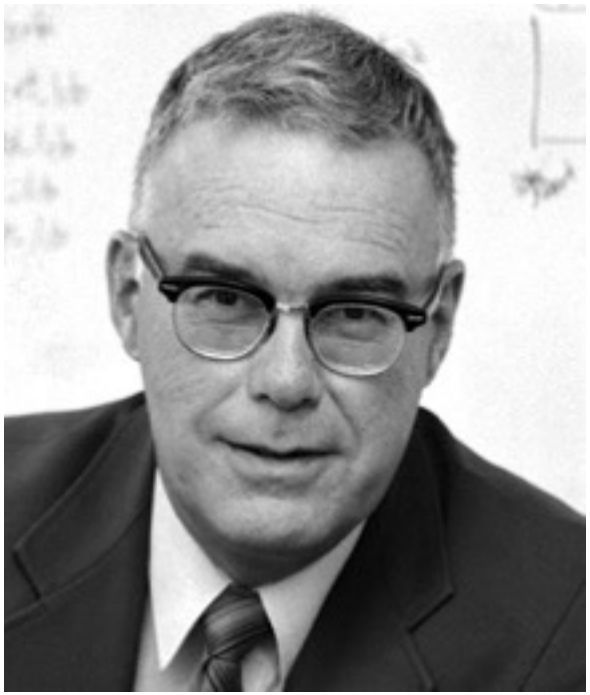
Ronald Woodman
Instituto Geofísico del Perú

Spunick, 1958



William E. Gordon

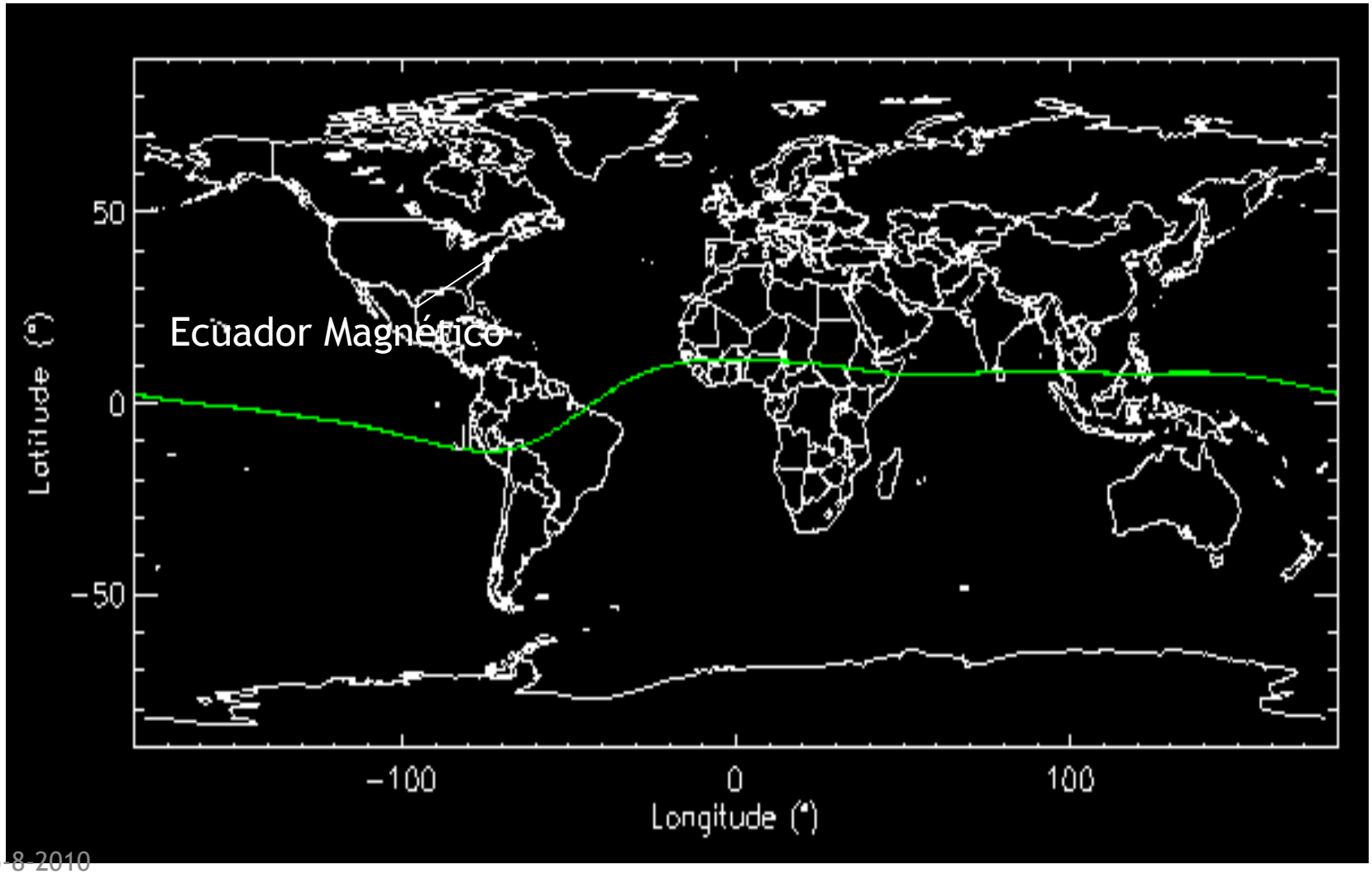
1958 paper, proposes the technique



Ken Bowles

- Performed succesfully the first Incoheren scatter experiment in Urbana, Illinois, 1958
- Proposed and build the the JRO, 1960-1962

Locus of Magnetic Equator



Lima and JRO Location

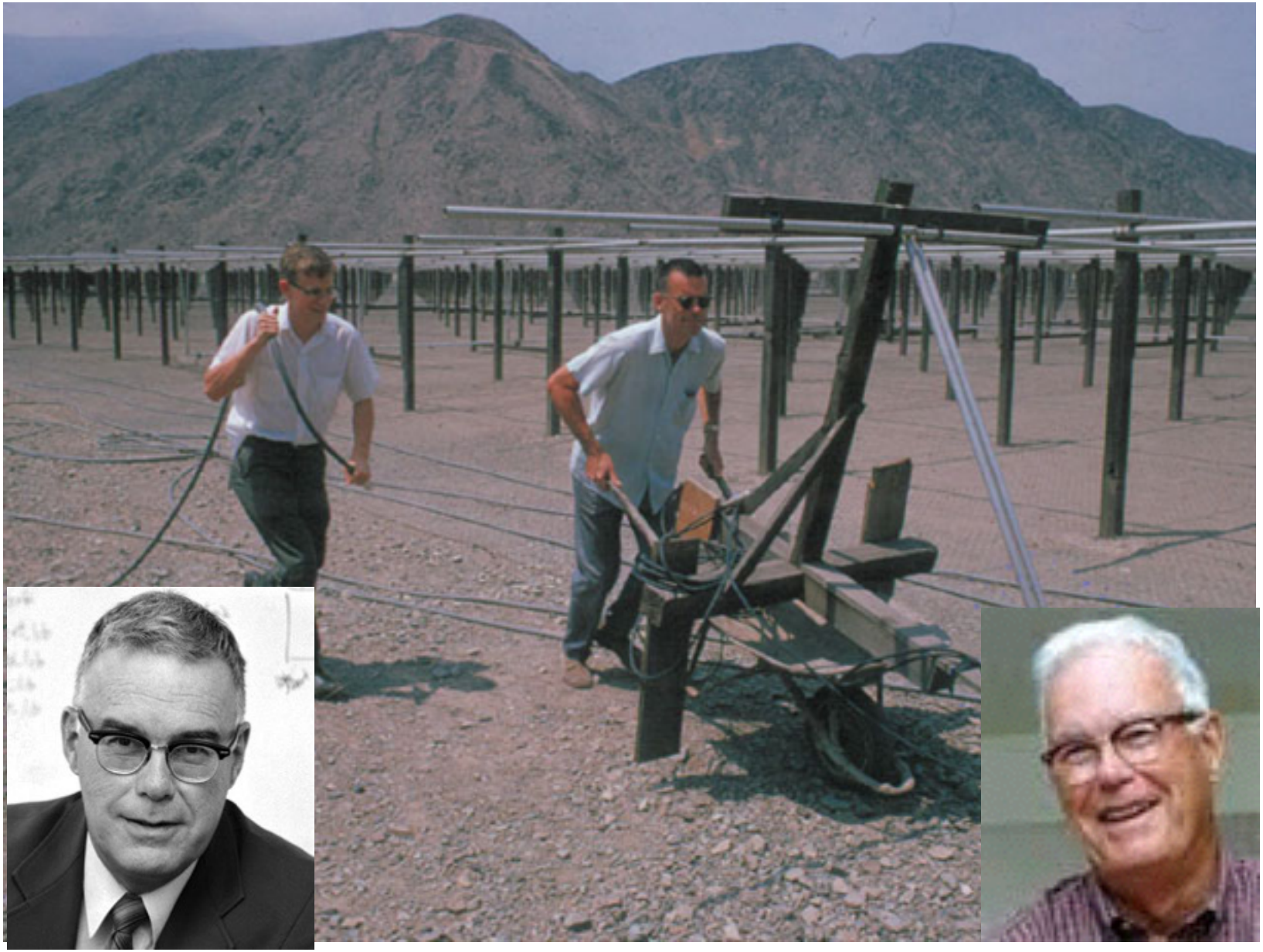
Bob Cohen and Ken Bowles checking the site for interference

Aerial look of the site chosen for construction

Huayco and cable chair

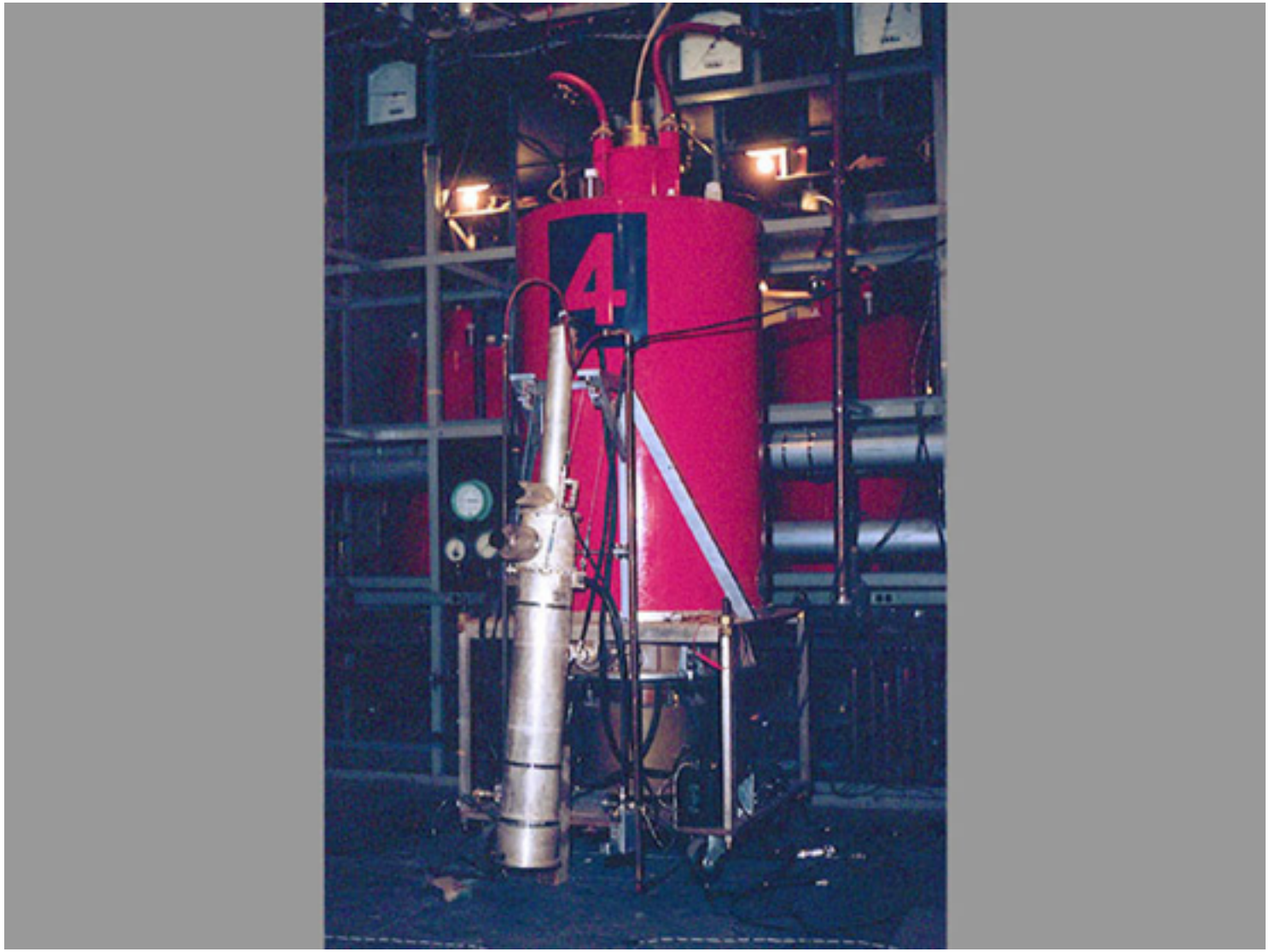
H. Ochs, Hector Cabada, Gerardo Vera. Antonio Arevalo and the golden dipole

Aluminum dipoles still shinning



Ken bowles positioning a dipole with his bear hands.
Young companion (Granger Morgan) has an easier job

Power Amplifier: Driver and Final
One of Four units



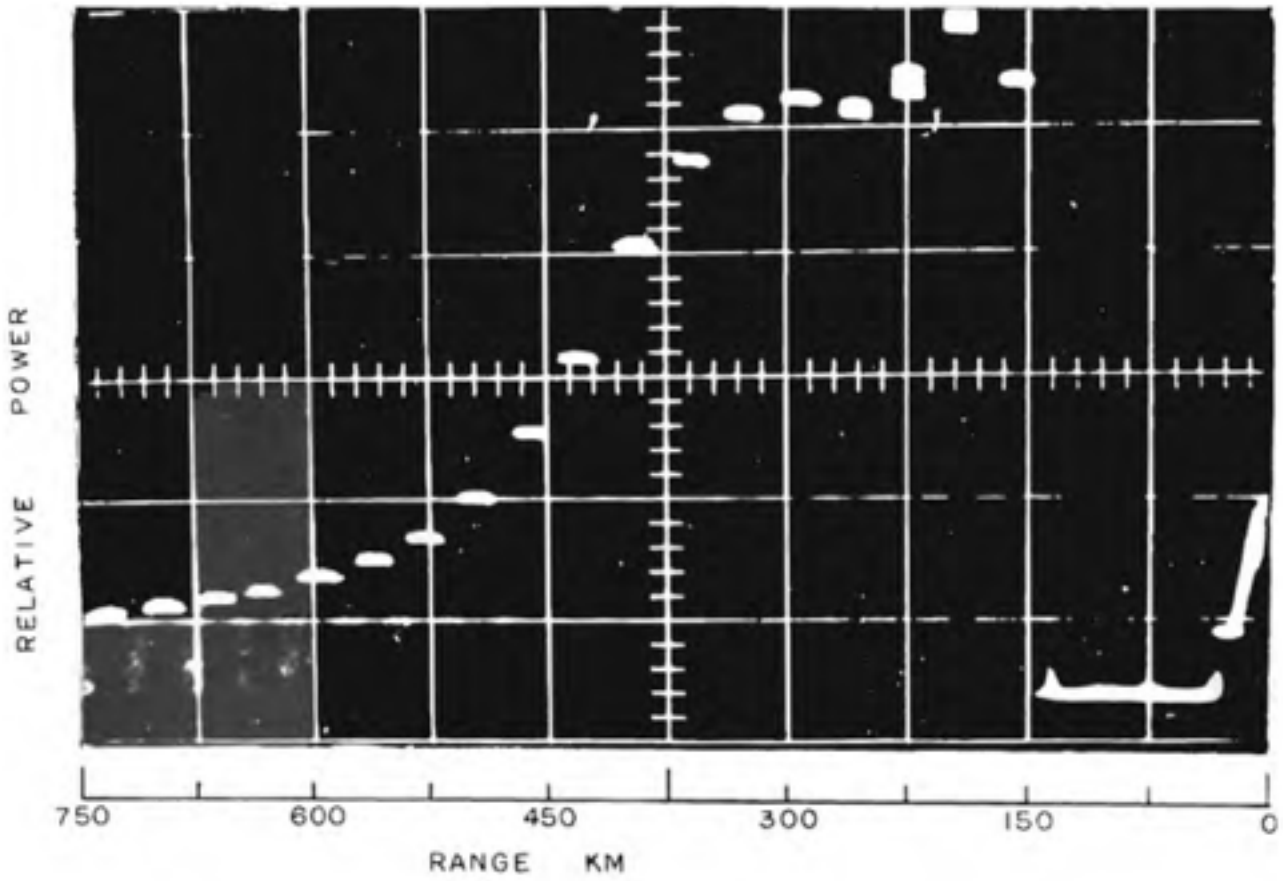


Figure 6 - Representative A'scope record with integration

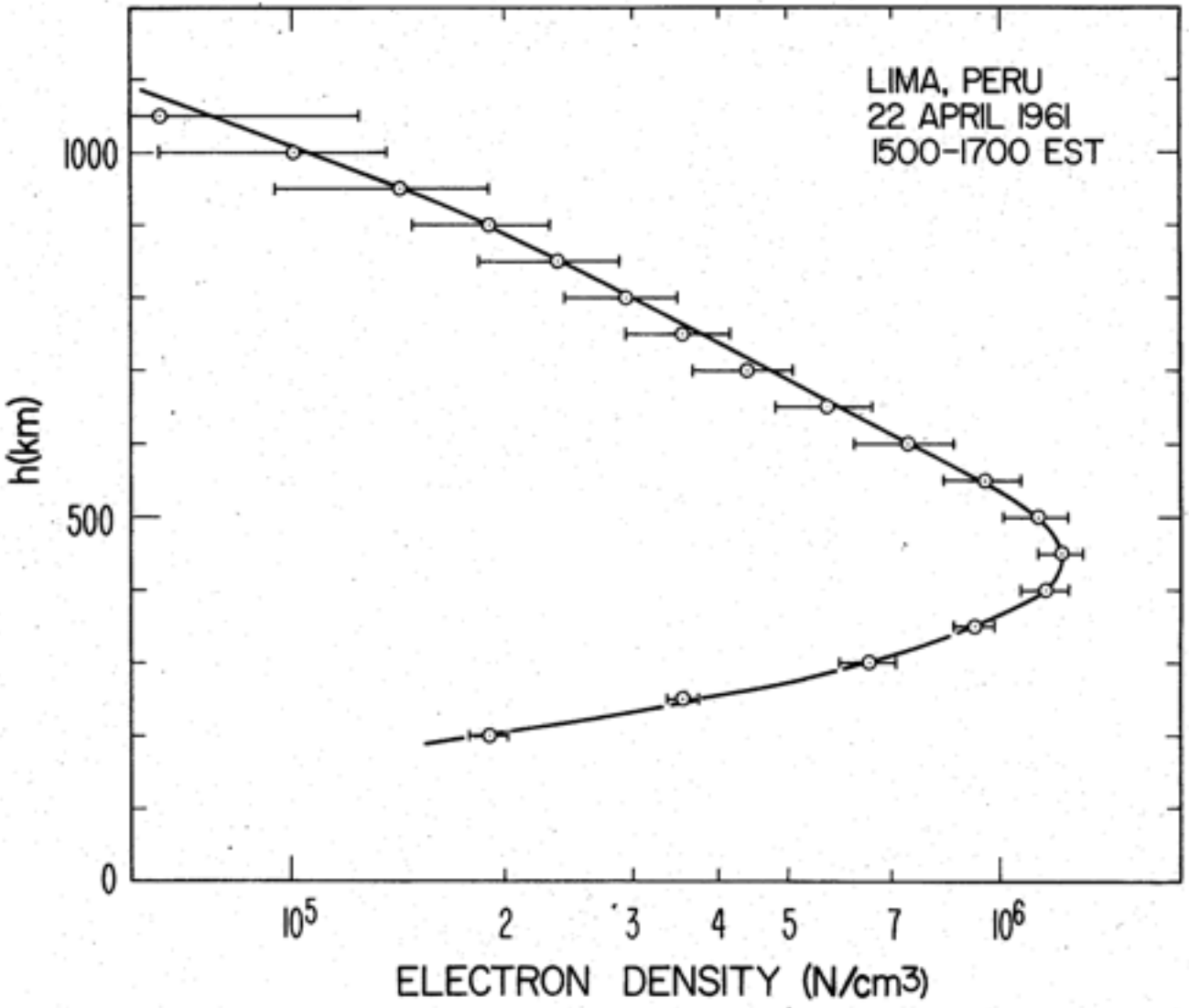
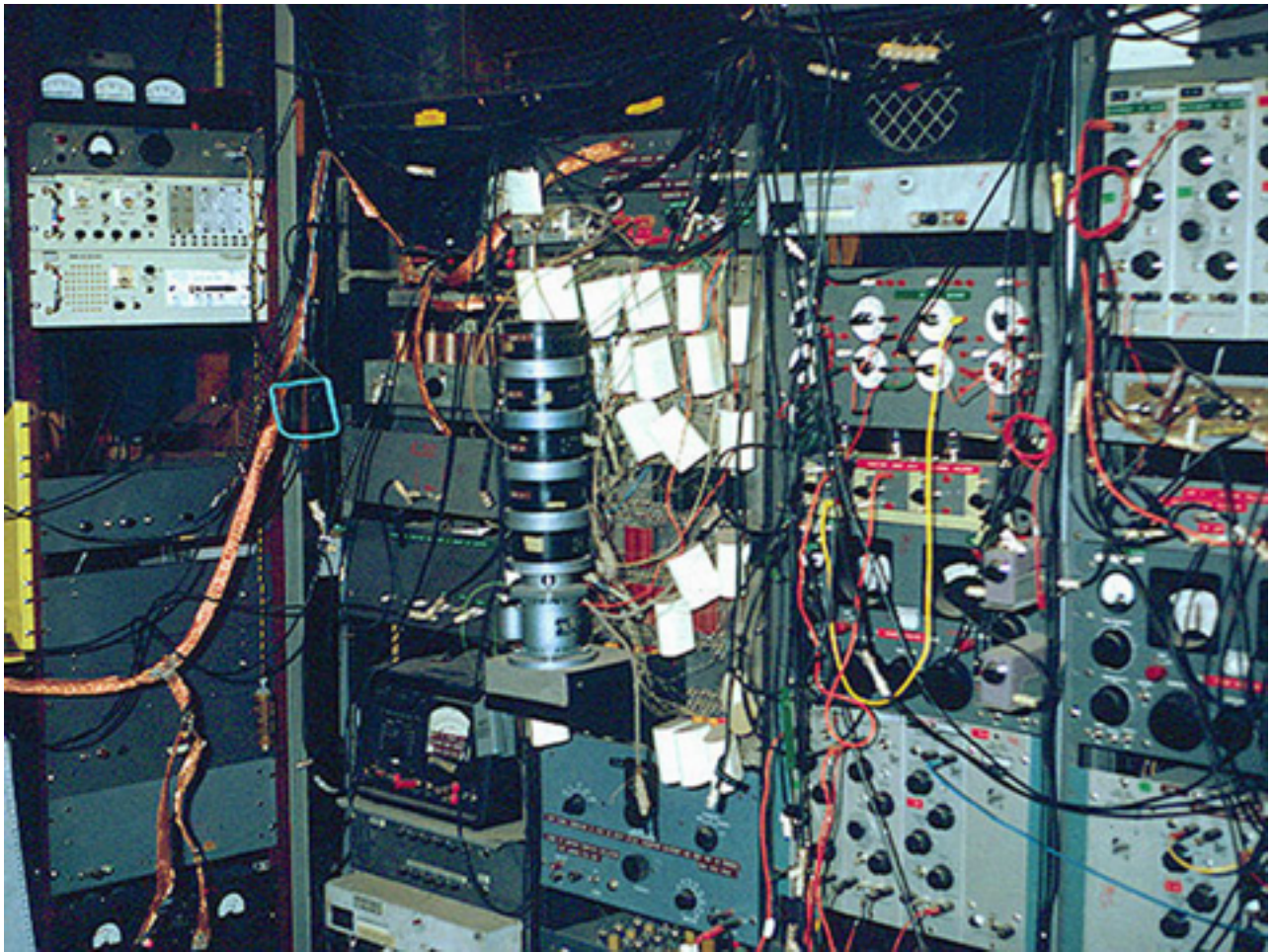

LIMA, PERU
22 APRIL 1961
1500-1700 EST
h(km)
1000
500
0
10^5
2
3
4
5
7
10^6
ELECTRON DENSITY (N/cm3)

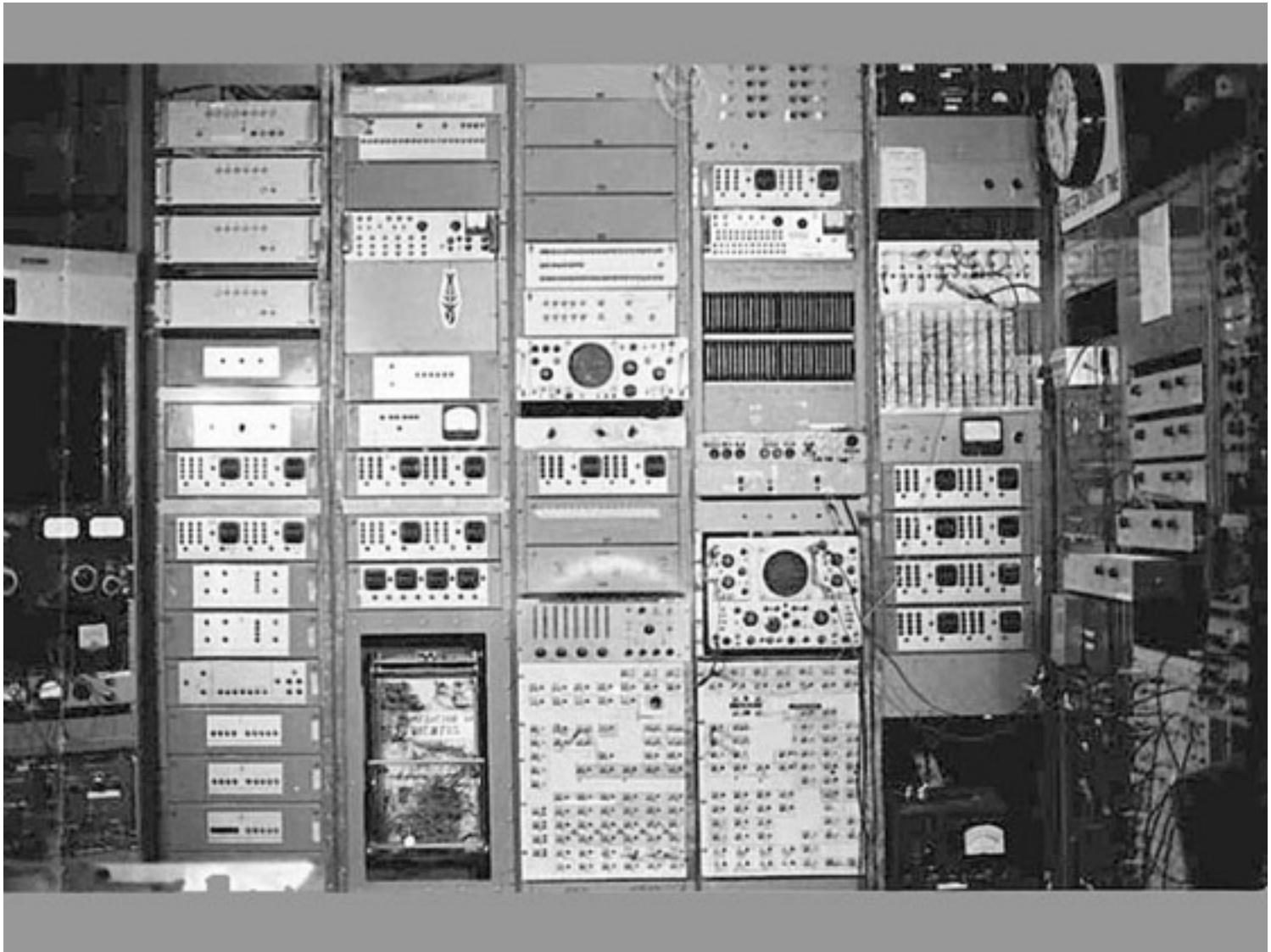
Figure 7

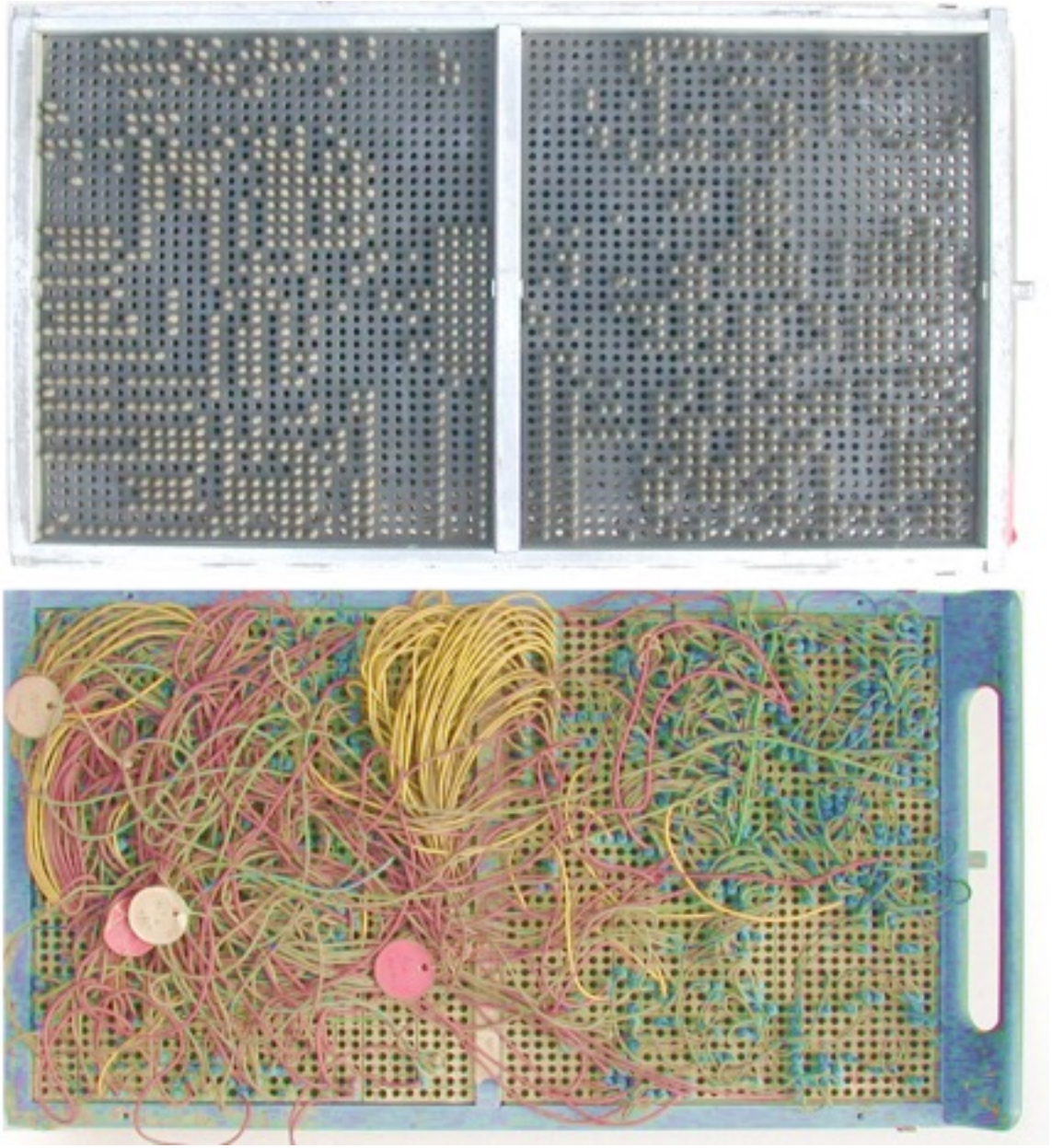
Receiver rack, 1960´s, note mercury switch



Mercury jet commutator

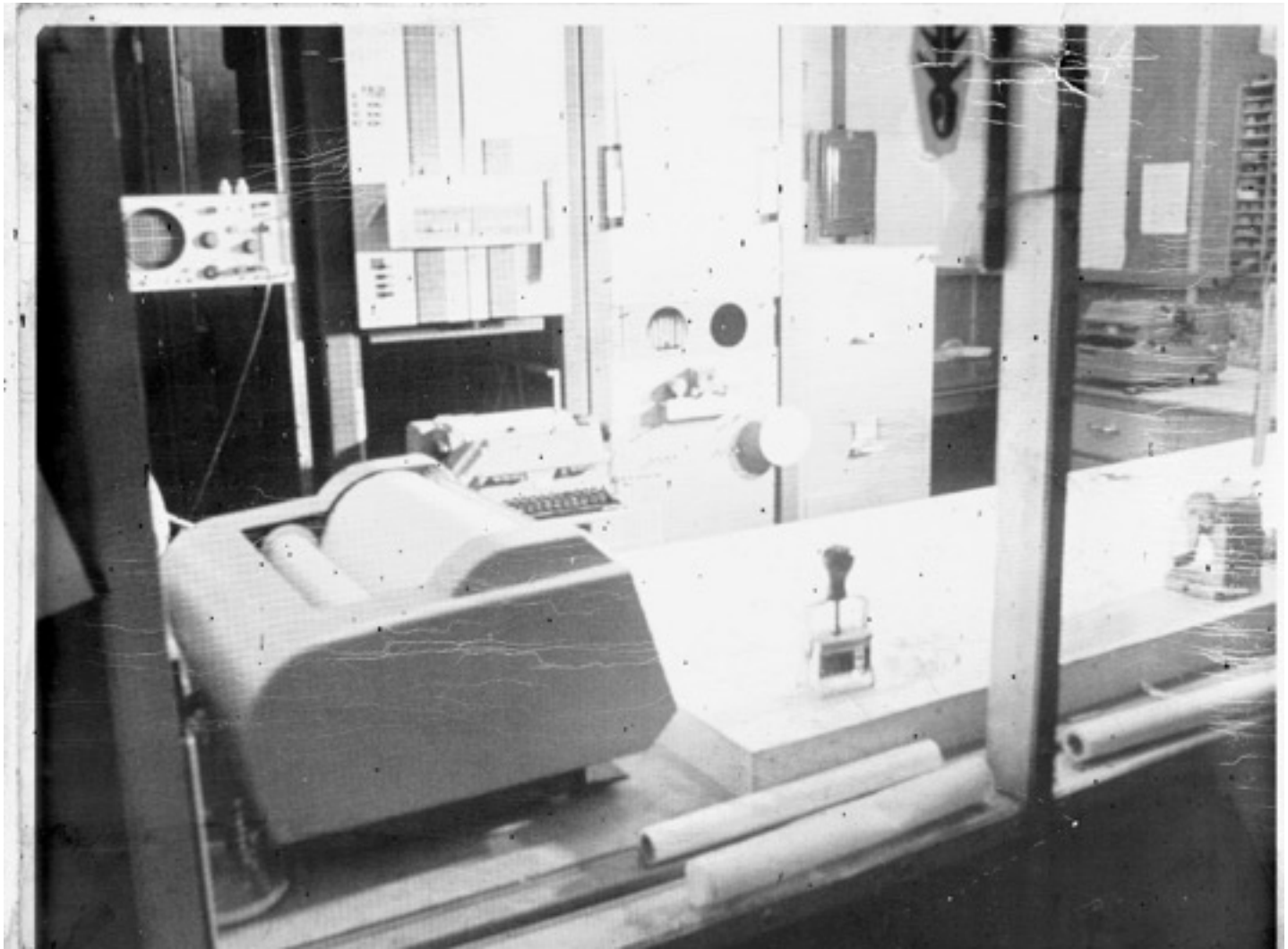
The correlator





Plug in board

PB250



pb Packard Bell Computer

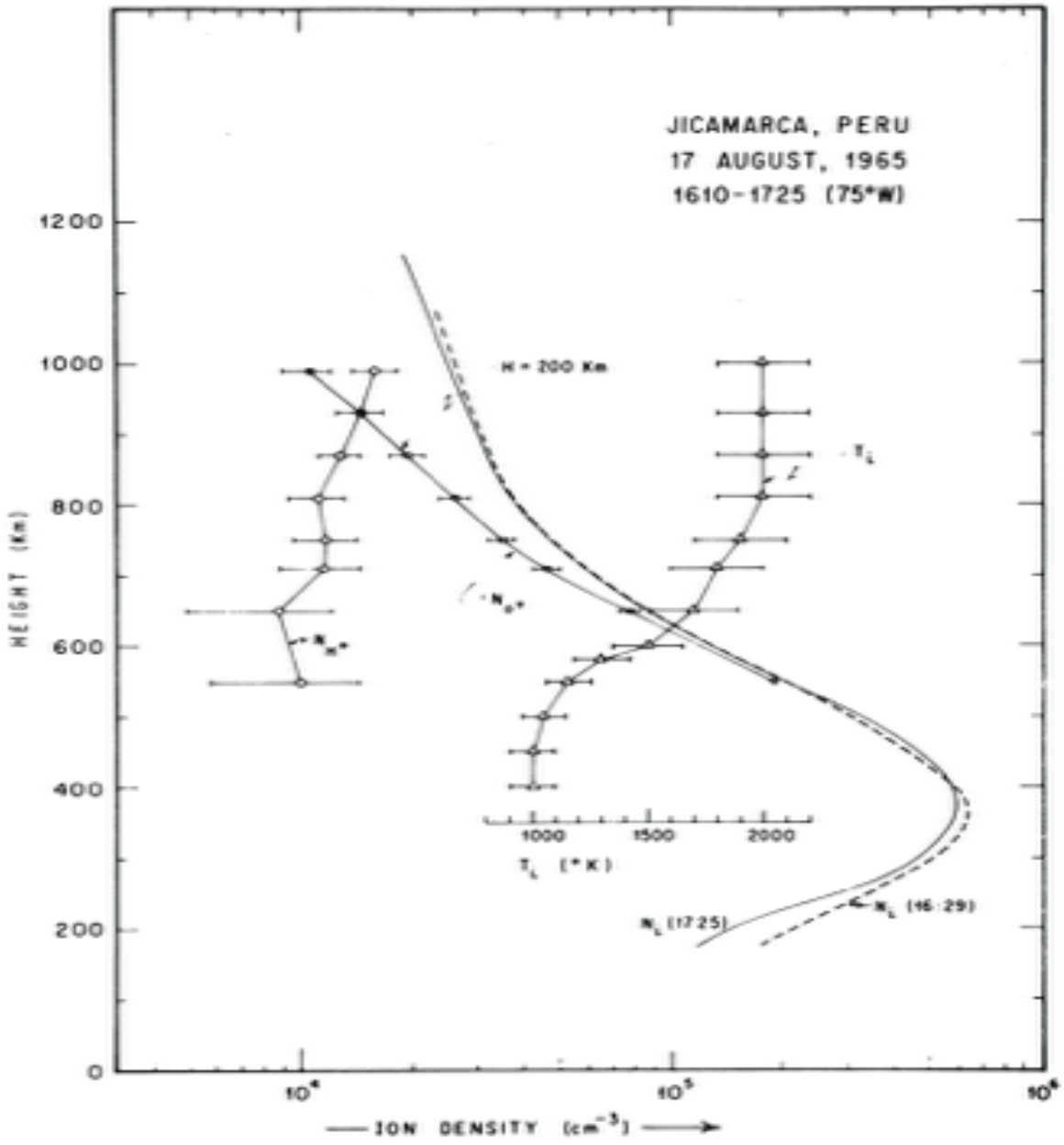
PB 250 CODING SHEET

PROGRAM NAME db scale PAGE 4 OF 5

PROGRAM NO. SPECIAL I. D.

BY DATE

LINE 11 SECTOR	INSTRUCTION					NOTES					
	SECTOR	S	OP.	LINE	I	SYMBOLIC OP CODE	LOCATION M	A REGISTER	B REGISTER	C REGISTER	INDEX REG.
140	141	5	04	11	;	LOC					
141	+00	0	04	00		const					
142	362		60	31	;	NOC	-x				
143	144	5	15	11	;	SUB					
144	+00	0	00	01		const					
145	147		35	11	;	TAN					
146	140	5	37	11	;	TRU					
147	150	5	05	11	;	LDA					
150	+00	0	00	04		const	half length of tick				
151	152	5	04	11	;	LOC					
152	+00	0	04	00		const					
153	353		60	21	;	NOC	+x				
154	155	5	15	11	;	SUB					
155	+00	0	00	01		const					
156	160		35	11	;	TAN					
157	151	5	37	11	;	TRU					
160	073		05	04	;	LDA					
161	208		35	11	;	TAN	jump if last point already taken				
162	072		15	04	;	SUB					
163	164	5	15	11	;	SUB					
164	+00	0	00	01		const					
165	172		35	11	;	TAN					
166	167	5	04	11	;	LOC					
167	+00	0	04	00		const					
170	370		60	24	;	NOC	+y				
171	163	5	37	11	;	TRU					
172	160		05	11	;	LDA					
173	176	5	14	11	;	ADD					
174	001		00	00	;	const	incre increment				
175	160		11	11	;	STA					
176	162	5	05	11	;	LDA					
177	200	5	14	11	;	ADD					


JICAMARCA, PERU
17 AUGUST, 1965
1610-1725 (75°W)
H = 200 Km
T_i
T_e
N_{O^+}
N_{H^+}
1000
1500
2000
T_i (°K)
N_e (17:25)
N_e (16:29)
HEIGHT (Km)
1200
1000
800
600
400
200
0
10^4
10^5
10^6
ION DENSITY (cm^{-3})

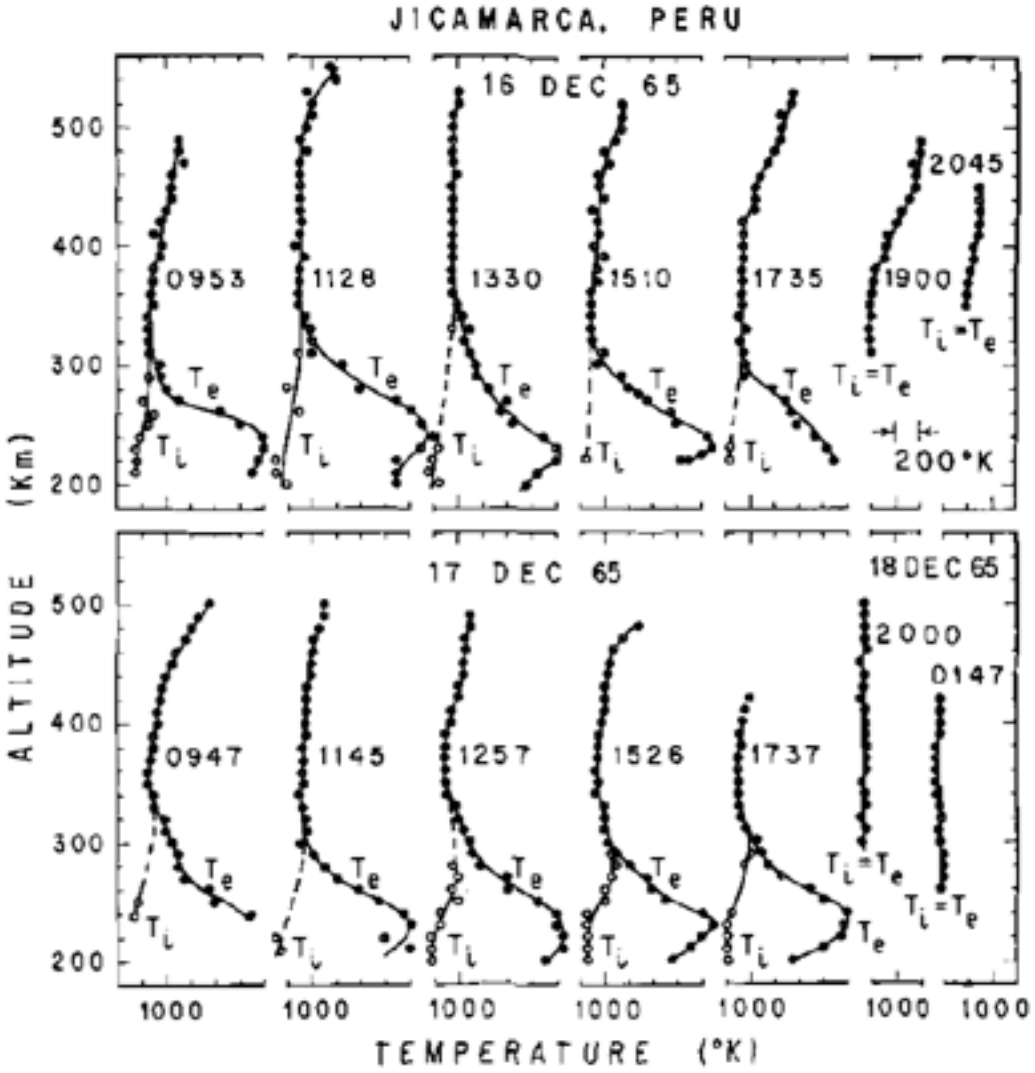
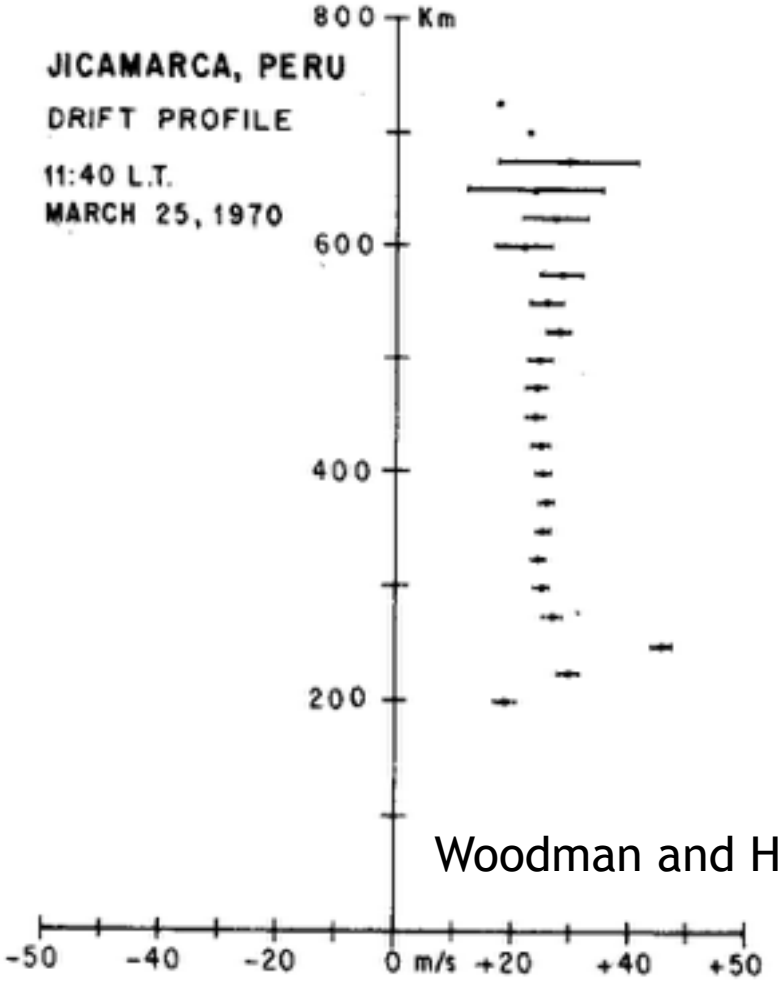


Fig. 5. A series of summer profiles of electron and ion temperatures.



Woodman and Hagfors, 1971

Fig. 1. Typical vertical velocity profile record obtained 'on line' at Jicamarca with 10 min of integration. The three lowest points are contaminated by strong electrojet echoes received through a side lobe of the antenna.

Woodman, 1971

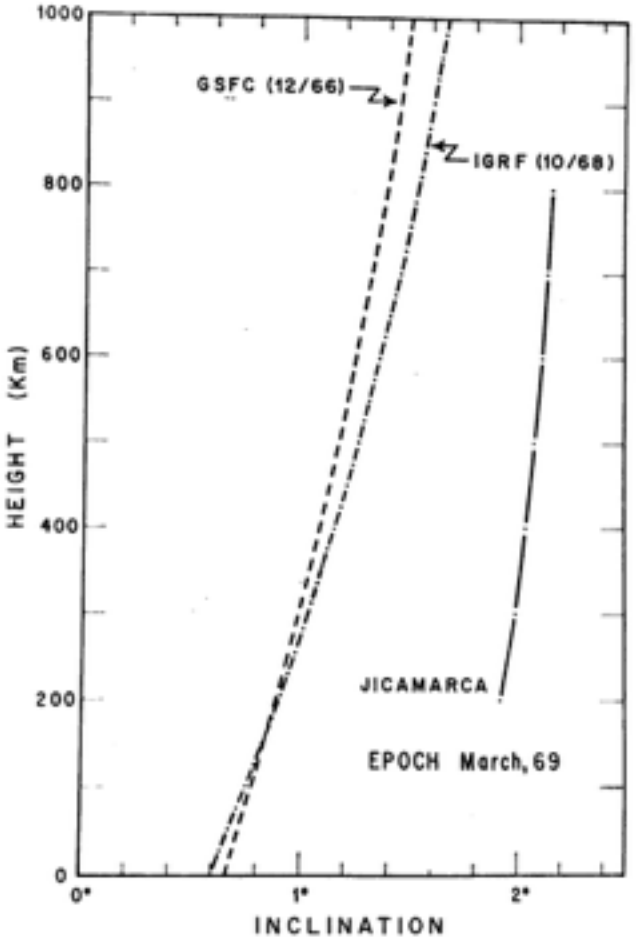
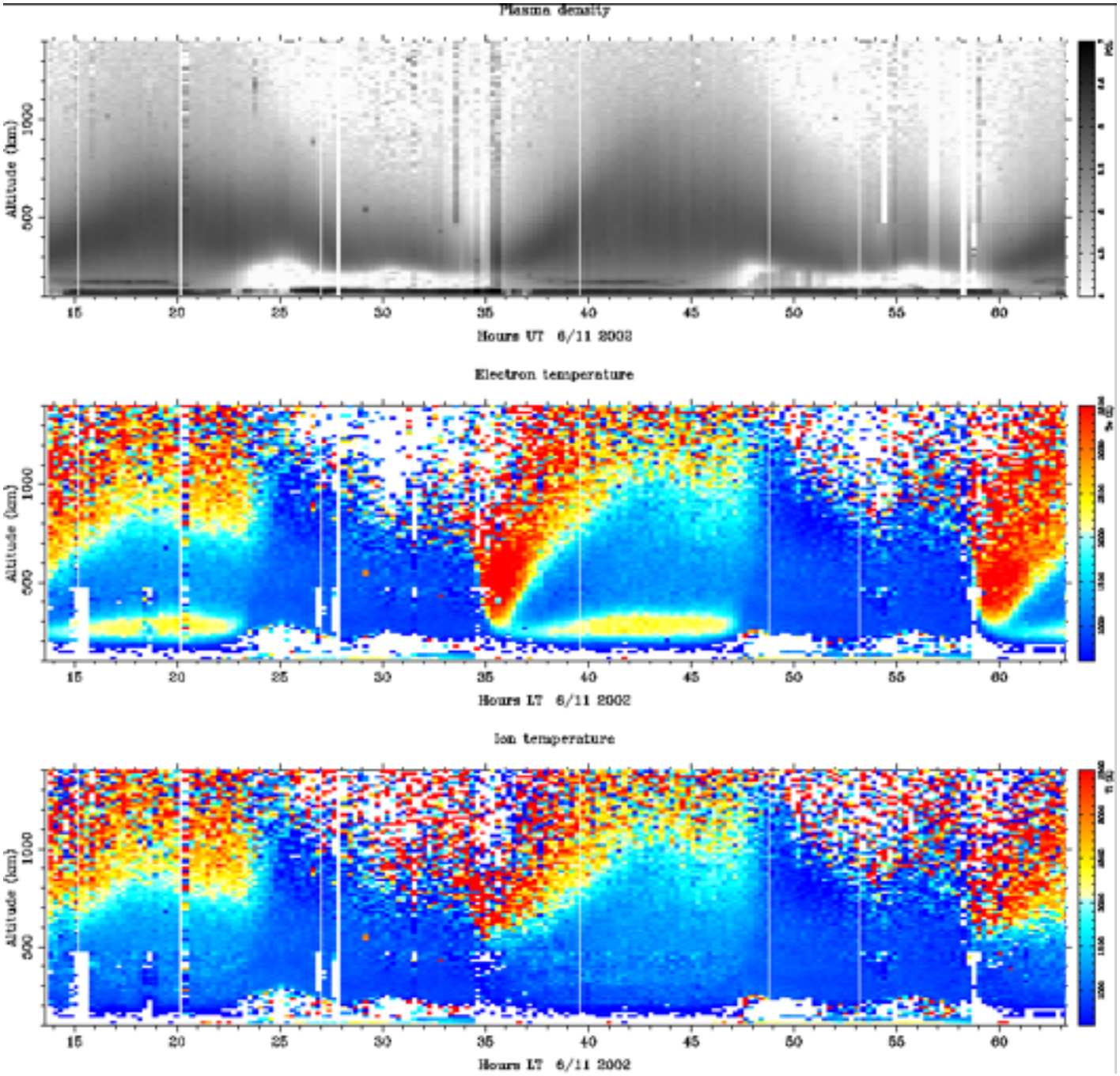


Fig. 6. Inclination of the magnetic field along Jicamarca vertical (—11.95° latitude 76°52′20″ longitude). The interrupted solid line corresponds to values determined experimentally at Jicamarca; the other two correspond to two of the latest earth magnetic field models, GSFC 12/66 and IGRF 10/68.

Ne
Te
Ti


Plasma density
Altitude (km)
500
1000
15
20
25
30
35
40
45
50
55
60
Hours UT 6/11 2002
Electron temperature
Altitude (km)
500
1000
15
20
25
30
35
40
45
50
55
60
Hours LT 6/11 2002
Ion temperature
Altitude (km)
500
1000
15
20
25
30
35
40
45
50
55
60
Hours LT 6/11 2002

Jicamarca, 1967, Elvis Presely?

En 1969, se transfiere el ROJ al IGP

- Some other contributions:
  - Spread F
  - *Electrojet Irregularities*
  - Other radars
  - + Rocket Campains

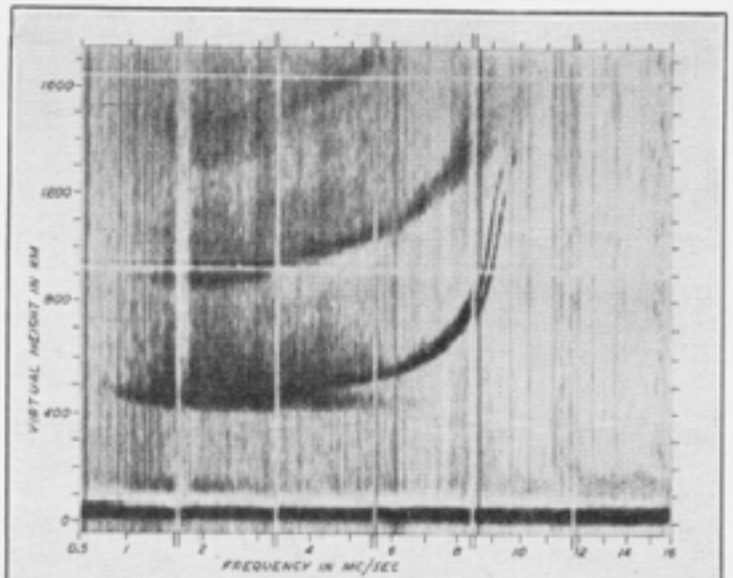


FIG. 1—RECORD SHOWING REGULAR AND DIFFUSE F-REGION ECHOES, HUANCAYO MAGNETIC OBSERVATORY, FEBRUARY 14, 1938, 20^h15^m–20^h30^m, 75° WEST MERIDIAN TIME

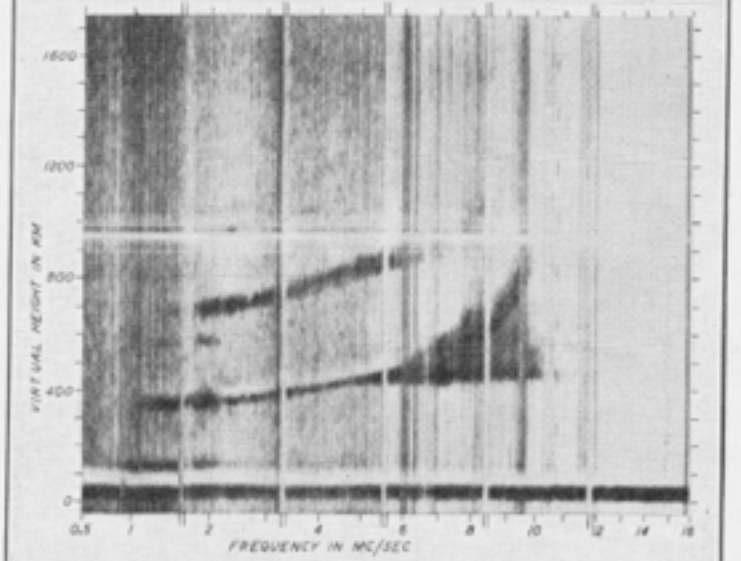
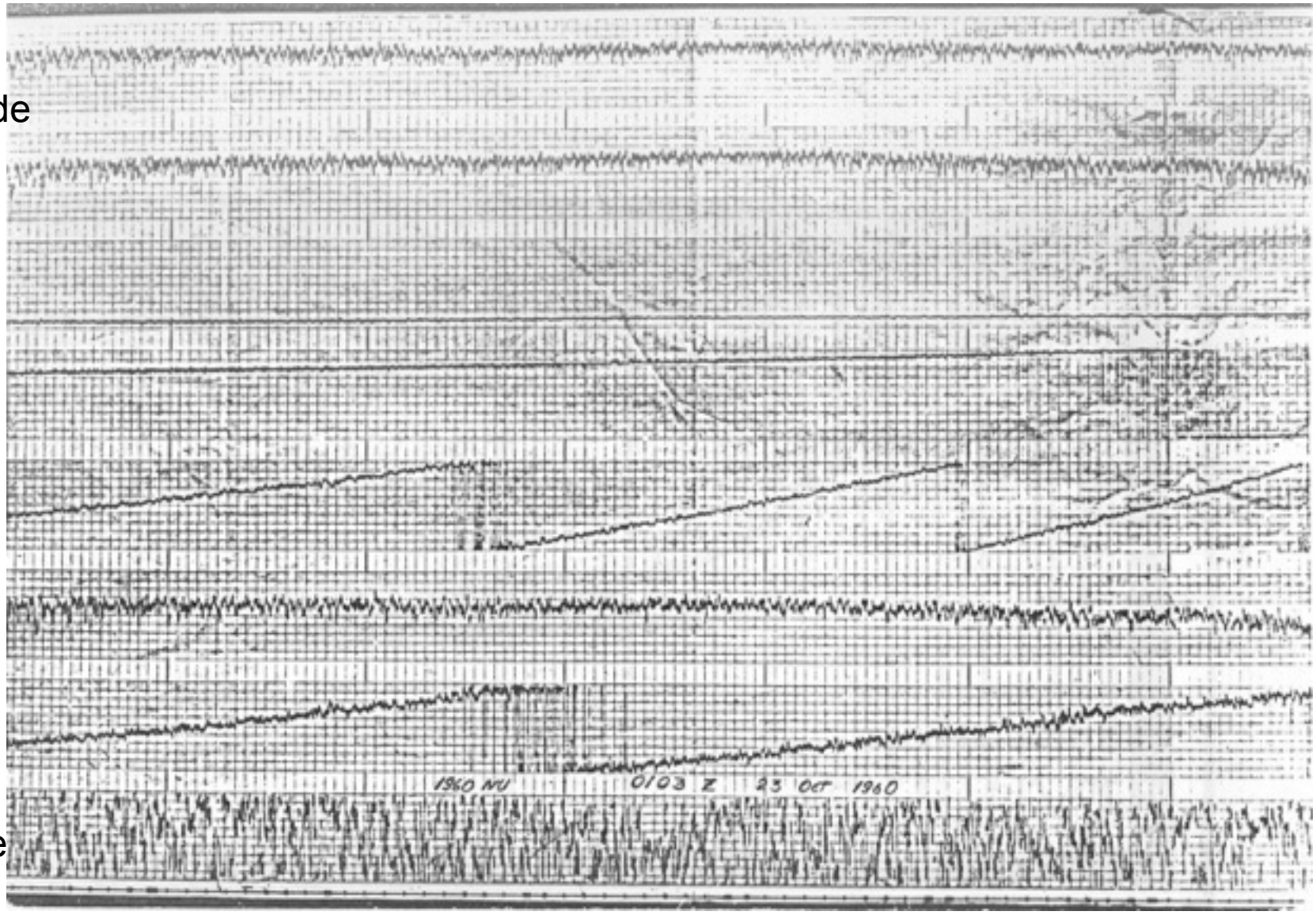


FIG. 2—RECORD SHOWING REGULAR AND DIFFUSE F-REGION ECHOES, HUANCAYO MAGNETIC OBSERVATORY, FEBRUARY 23, 1938, 21^h30^m–21^h45^m, 75° WEST MERIDIAN HOURS



Satellite phase scintillation, Woodman. 1960

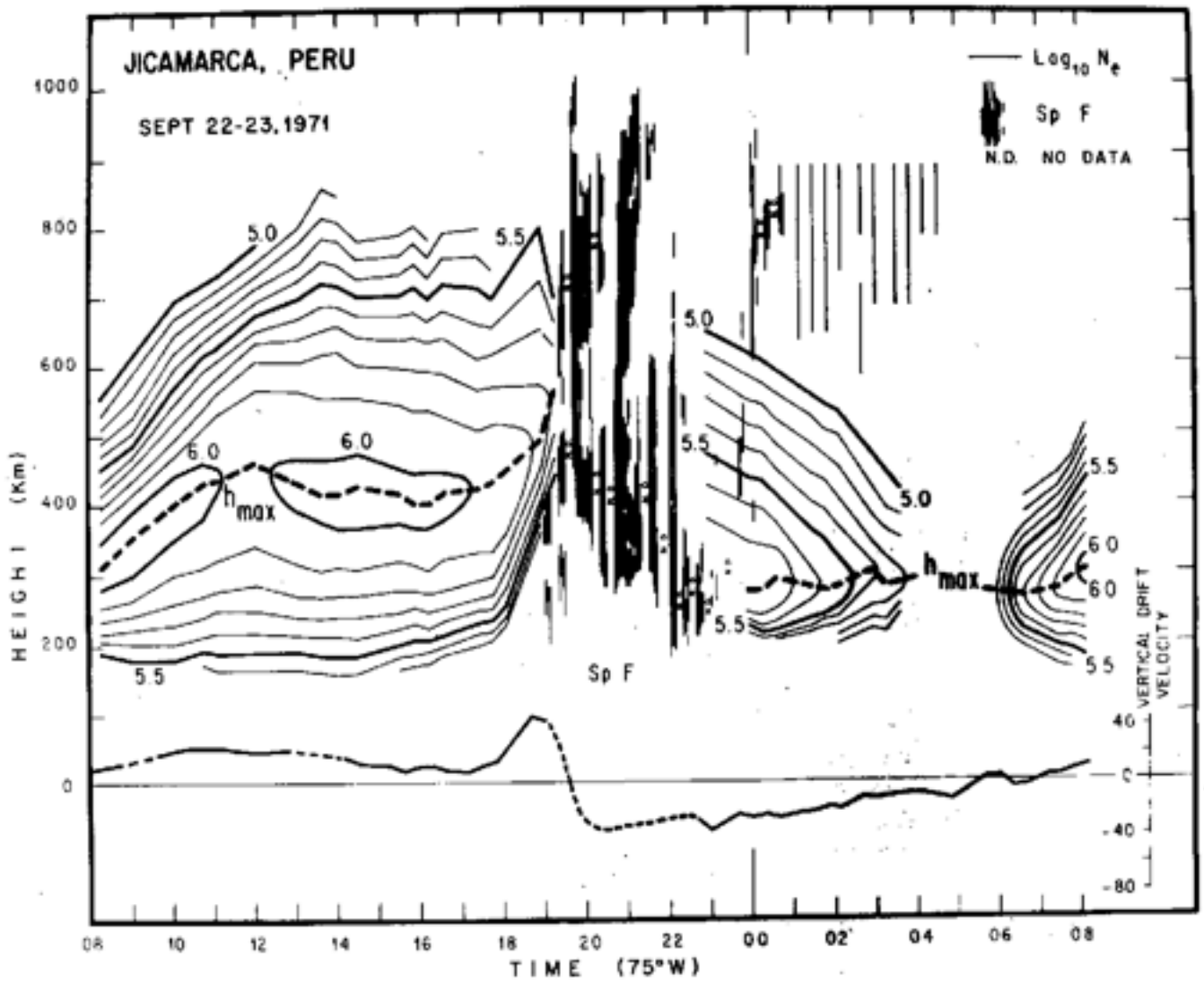


Fig. 2. Altitude range and time of occurrence of spread *F* echoes and their relation to the electron density, electron density gradients, and vertical drifts at *F* region heights.

After Woodman and La Hoz, 1976.
Ilustrates Farley et al, 1970, conclusions

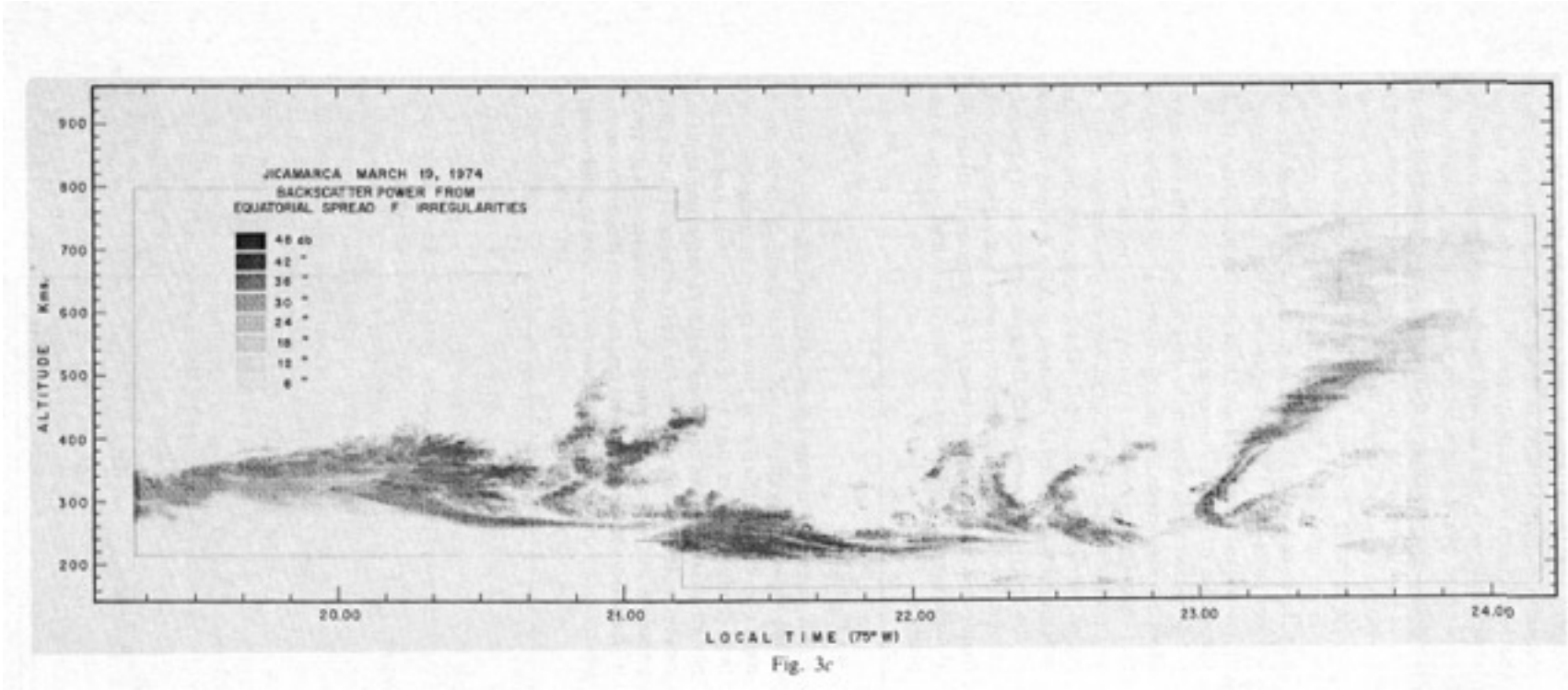
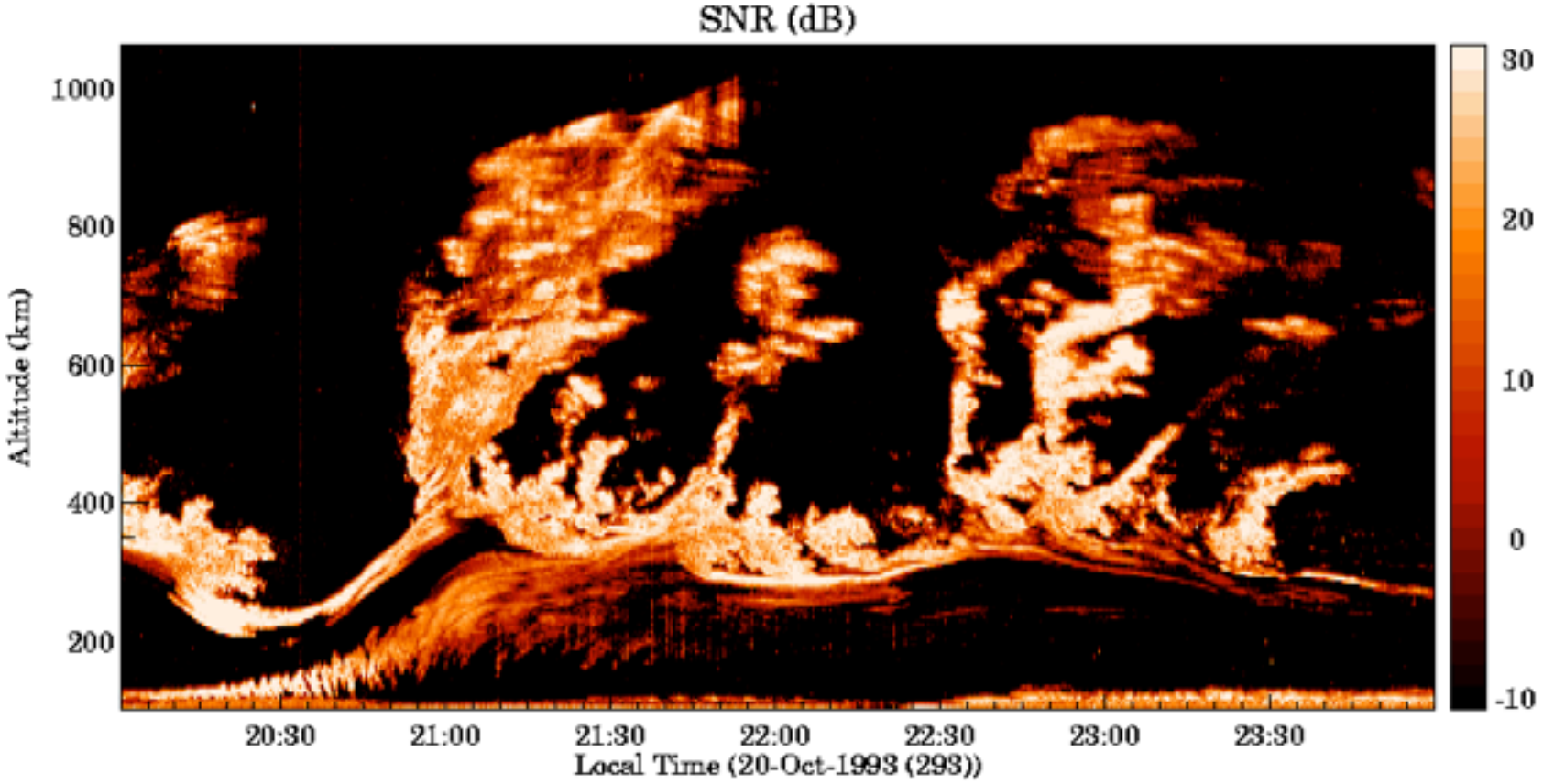


Fig. 3c

Woodman and La Hoz, 1976

ESF echoes

(from *Woodman and Chau* [2001])



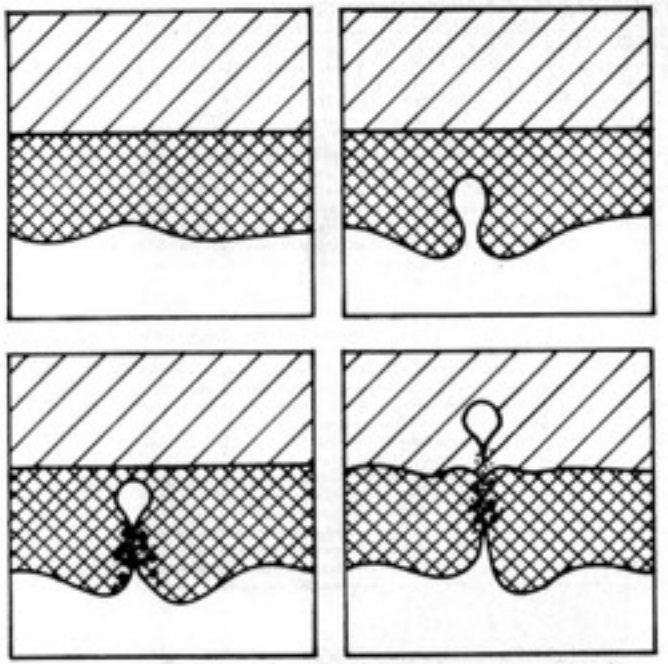
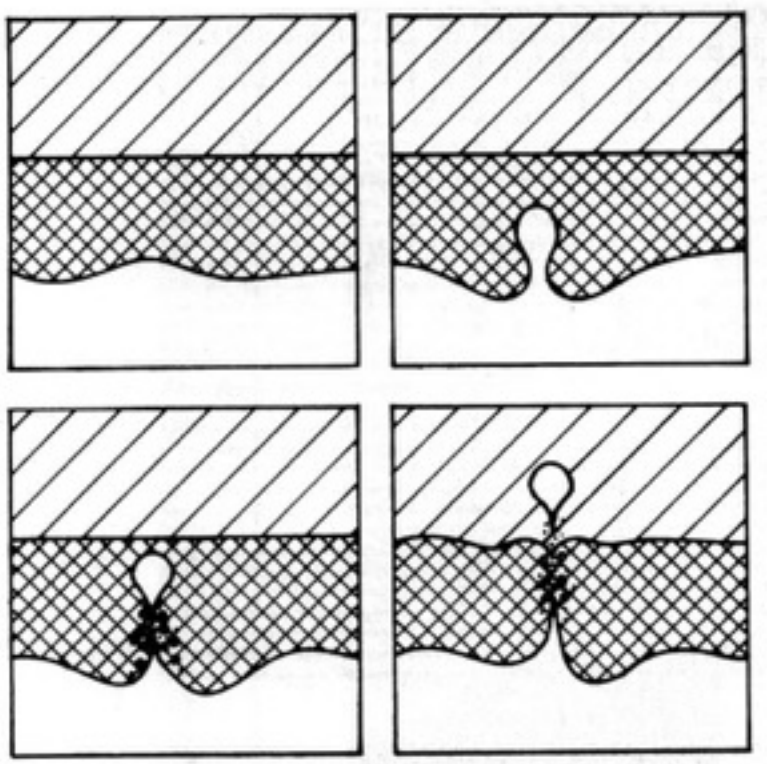
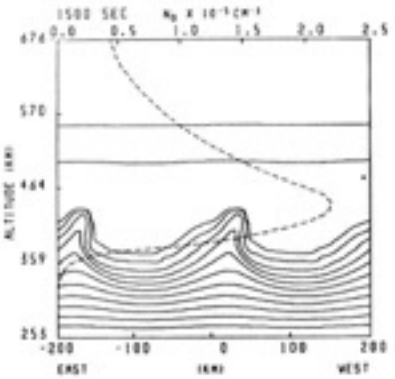
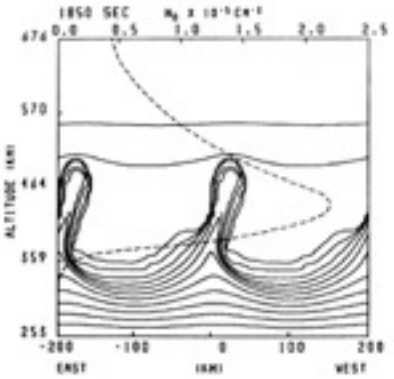


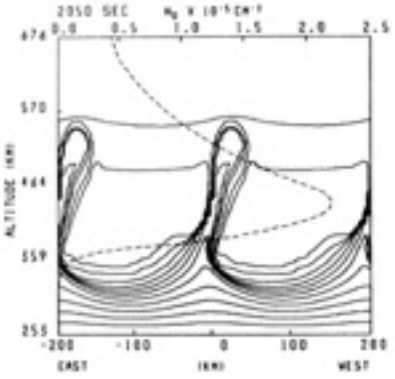
Fig. 9. Schematic representation of a three-density model of the ionosphere showing the formation of a bubble of low electron density and its propagation to the gravitationally stable top. The middle fluid is heavier than the top, and the top fluid heavier than the bottom.

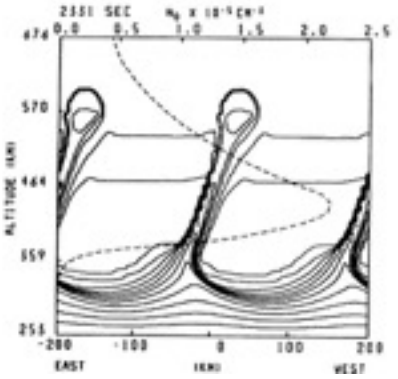
Woodman and La Hoz, 1976



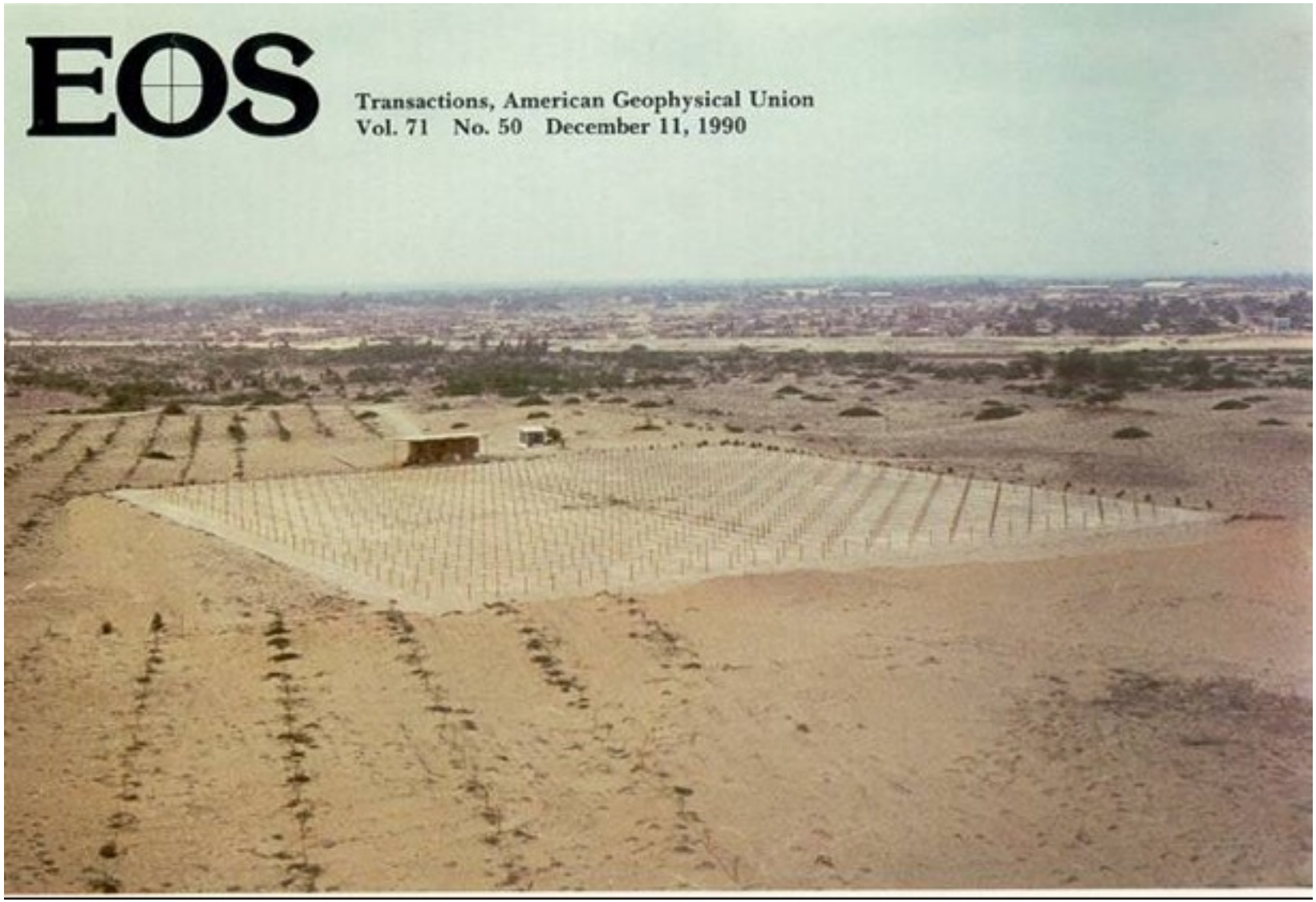

1500 SEC
0.0 0.5 1.0 1.5 2.0 2.5
674
570
464
359
255
ALTITUDE (KM)
-200 -100 0 100 200
EAST (KM) WEST


1850 SEC
0.0 0.5 1.0 1.5 2.0 2.5
674
570
464
359
255
ALTITUDE (KM)
-200 -100 0 100 200
EAST (KM) WEST

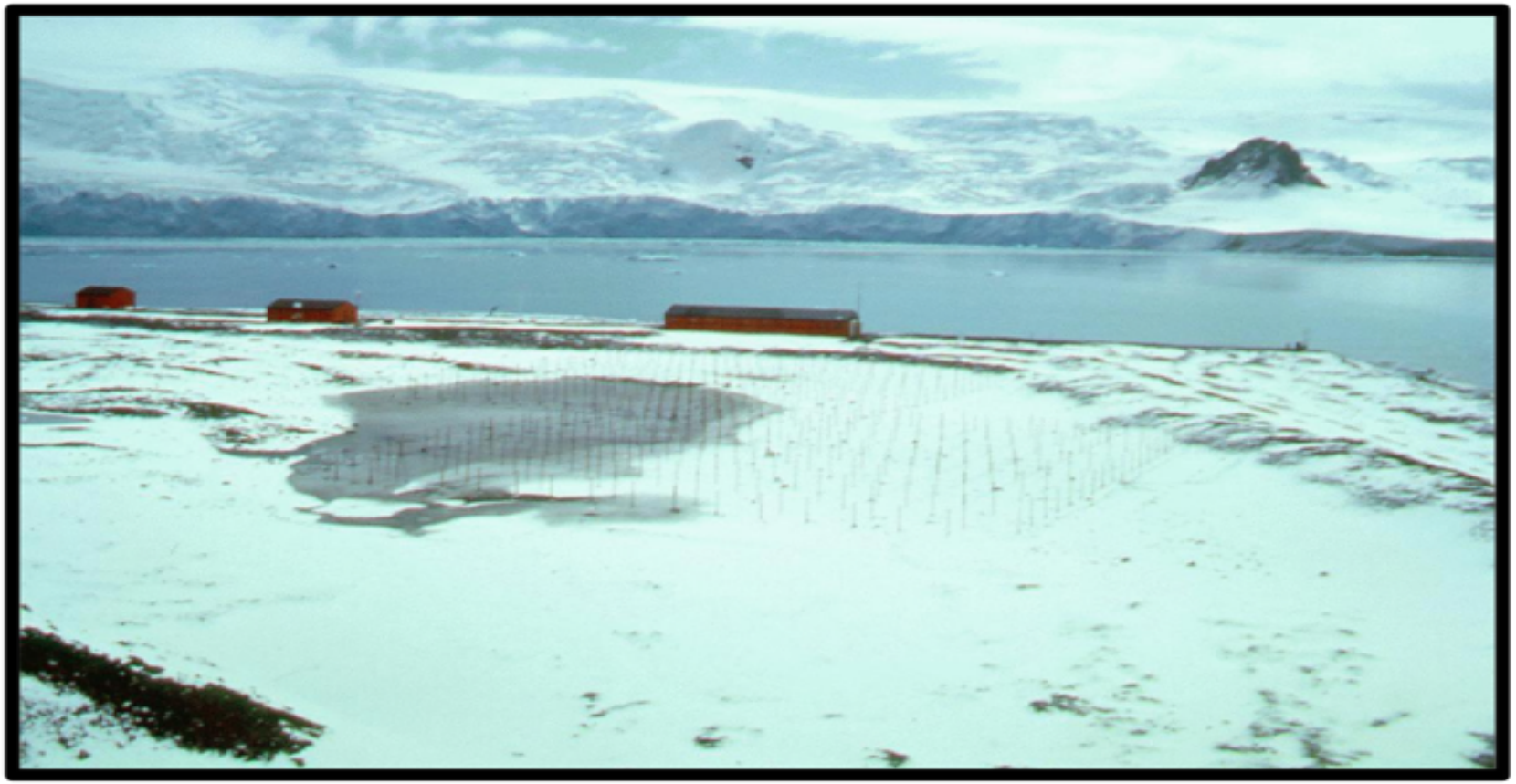

2050 SEC
0.0 0.5 1.0 1.5 2.0 2.5
674
570
464
359
255
ALTITUDE (KM)
-200 -100 0 100 200
EAST (KM) WEST


2331 SEC
0.0 0.5 1.0 1.5 2.0 2.5
674
570
464
359
255
ALTITUDE (KM)
-200 -100 0 100 200
EAST (KM) WEST

Piura ST


EOS
Transactions, American Geophysical Union
Vol. 71 No. 50 December 11, 1990

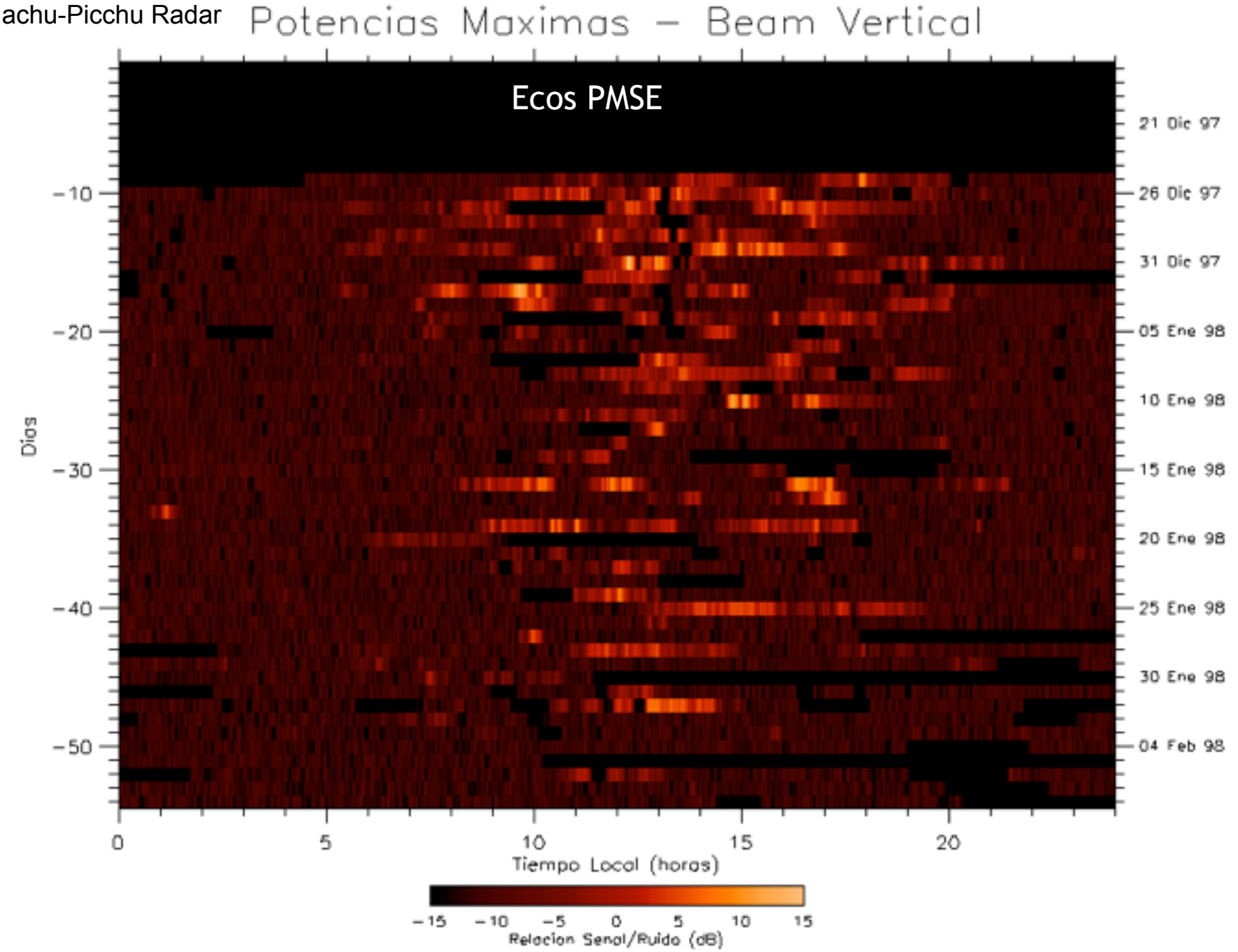
RADAR ANTARTICO "MST"



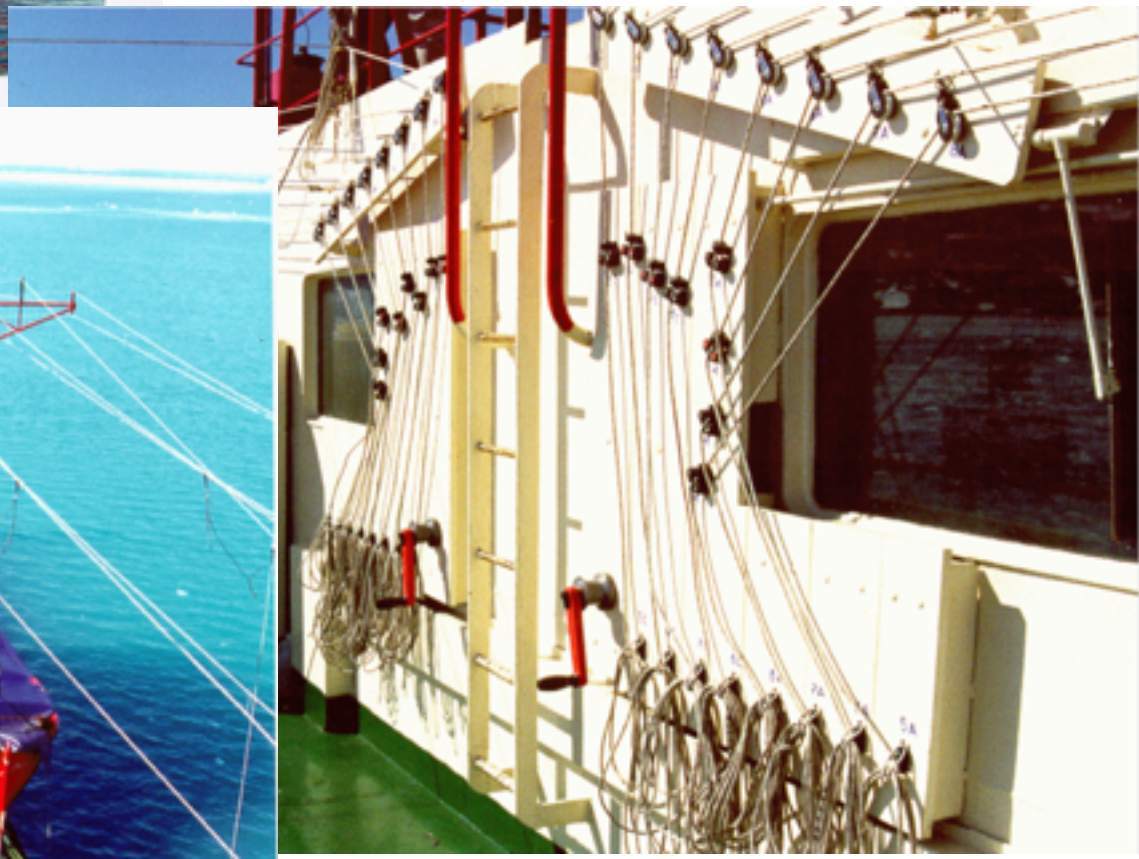
IX EXPEDICION CIENTIFICA

Estación Científica "MACHU PICCHU"

Machu-Picchu Radar




HUMBOLDT



Thank you