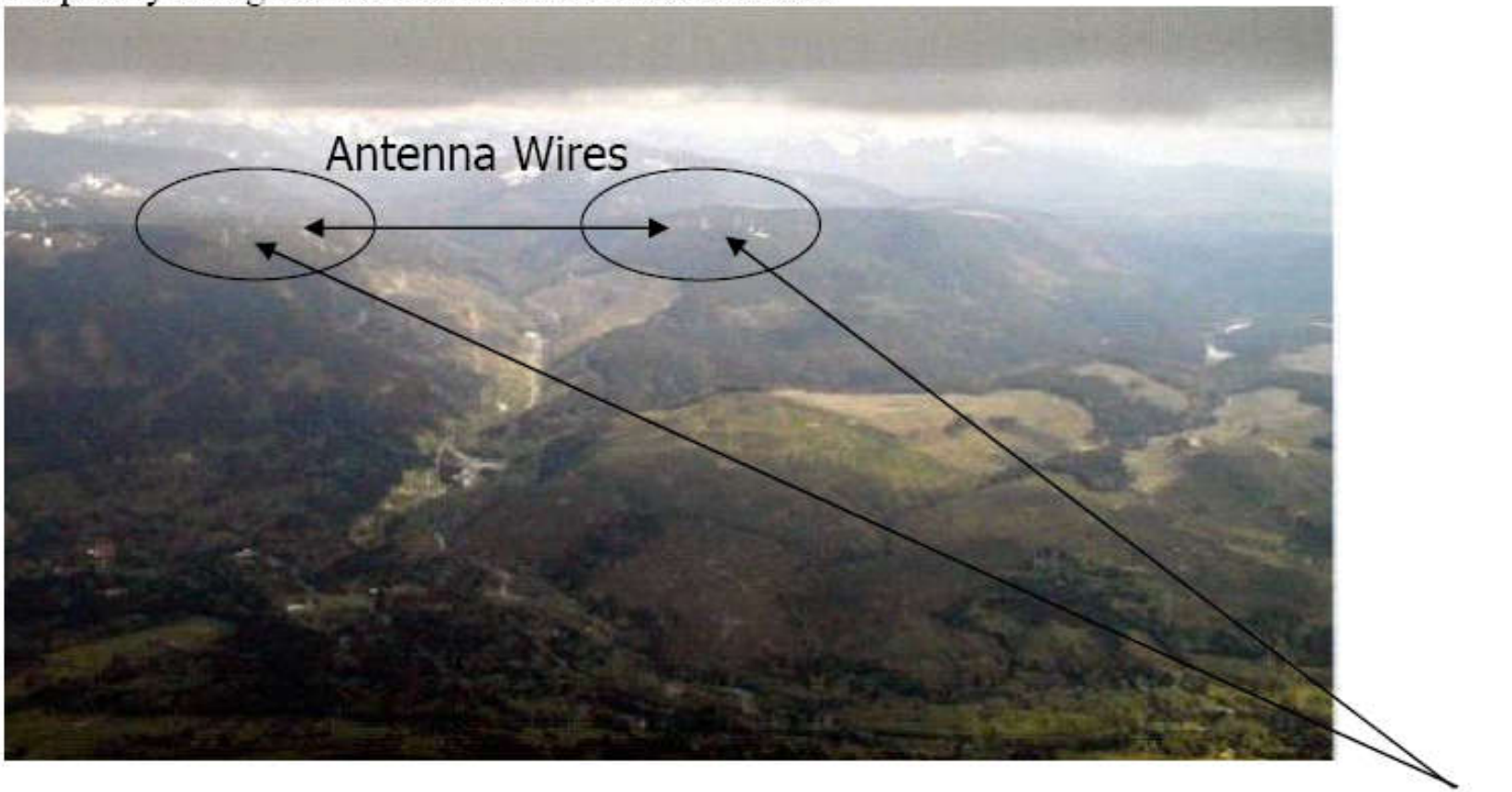
Solar Flare Monitor

- A simple SID radio receiver

- Brian Fraser

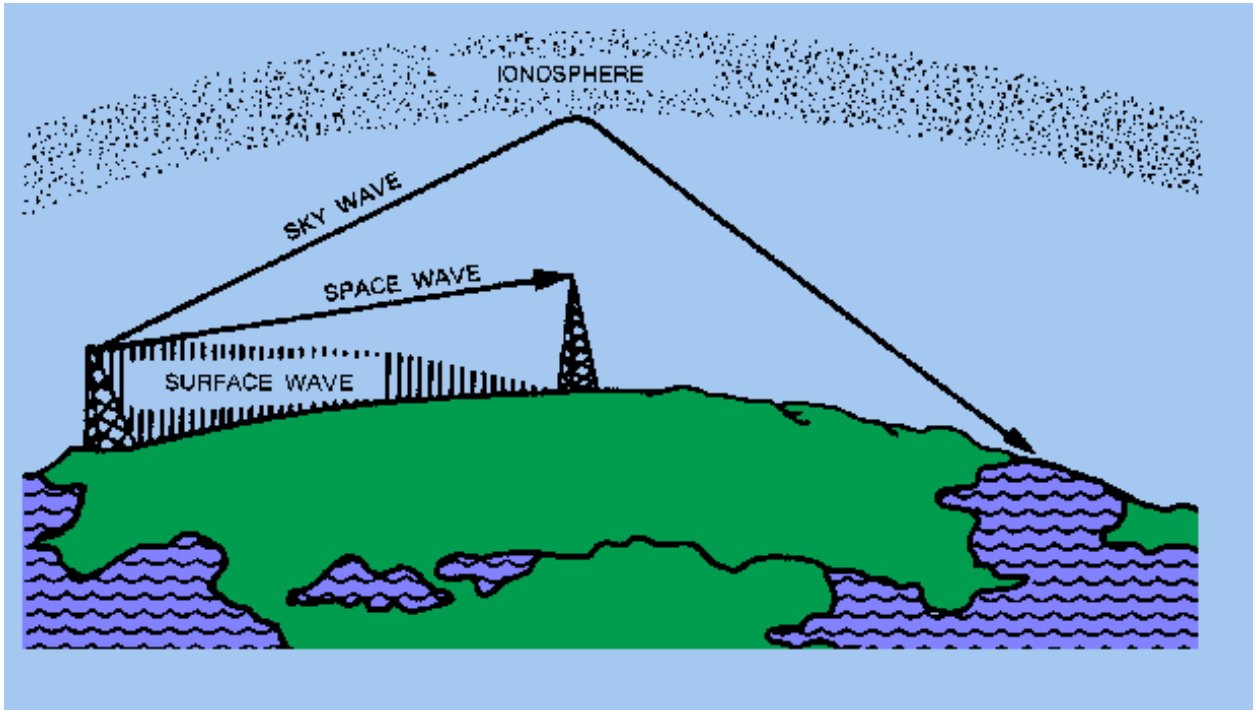
The transmitter stations are usually very large, covering many kilometers. The site in the picture below is the US Navy Radio Station in Jim Creek, Washington, USA. Note that the antenna wires span from mountain top to mountain top, since the wavelength of the frequency being transmitted is about 12 kilometers.

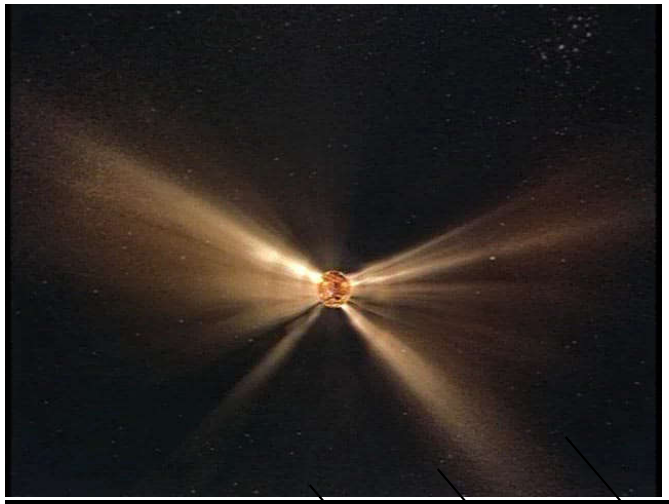


"NLK" 24.8 kHz US Navy Radio Station, Jim Creek, WA
wavelength 12 km (7.5 miles)

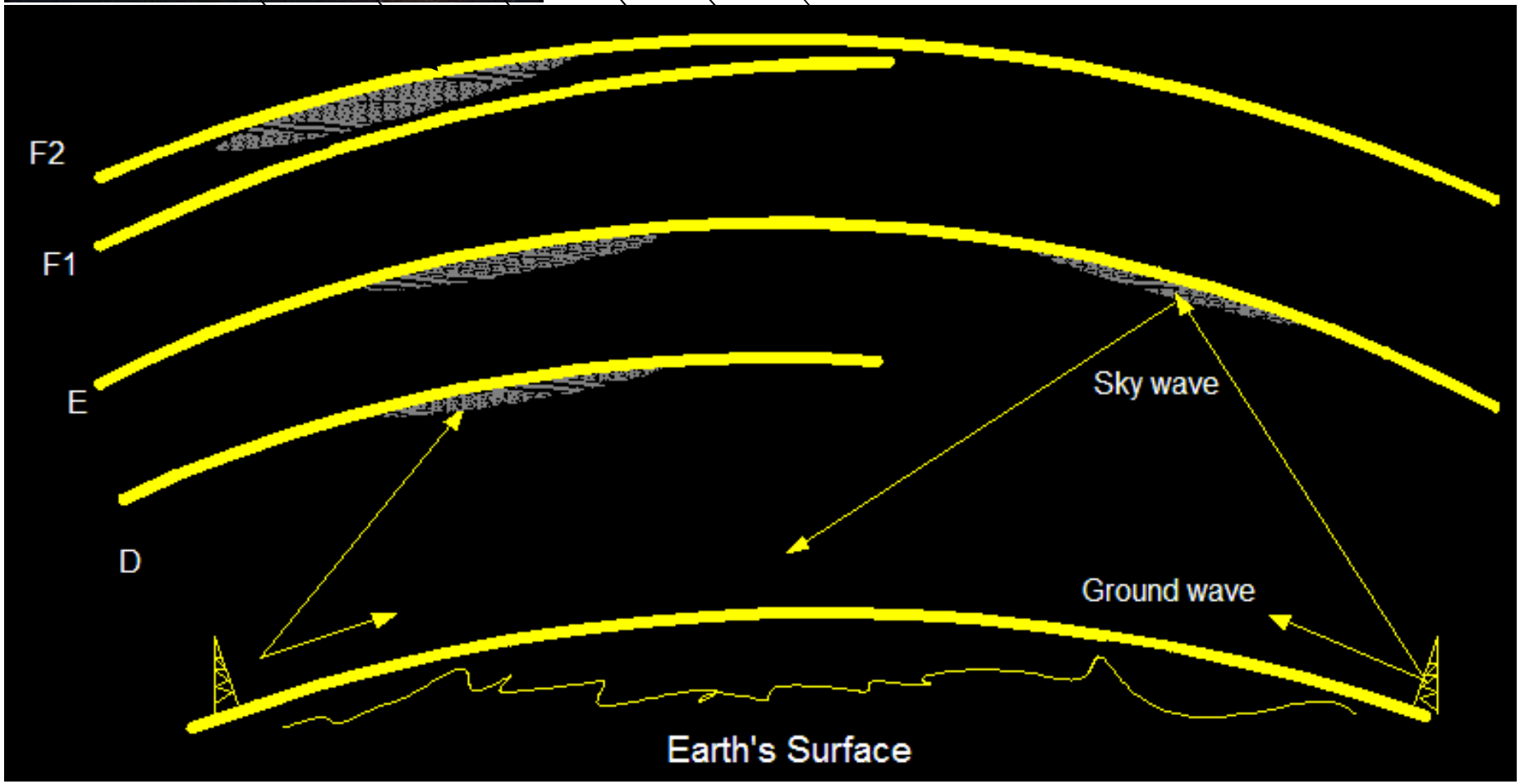
Transmission of VLF through the Ionosphere

- Radio waves reflected by the Ionosphere – acts like a mirror (because ions present in the Ionosphere)



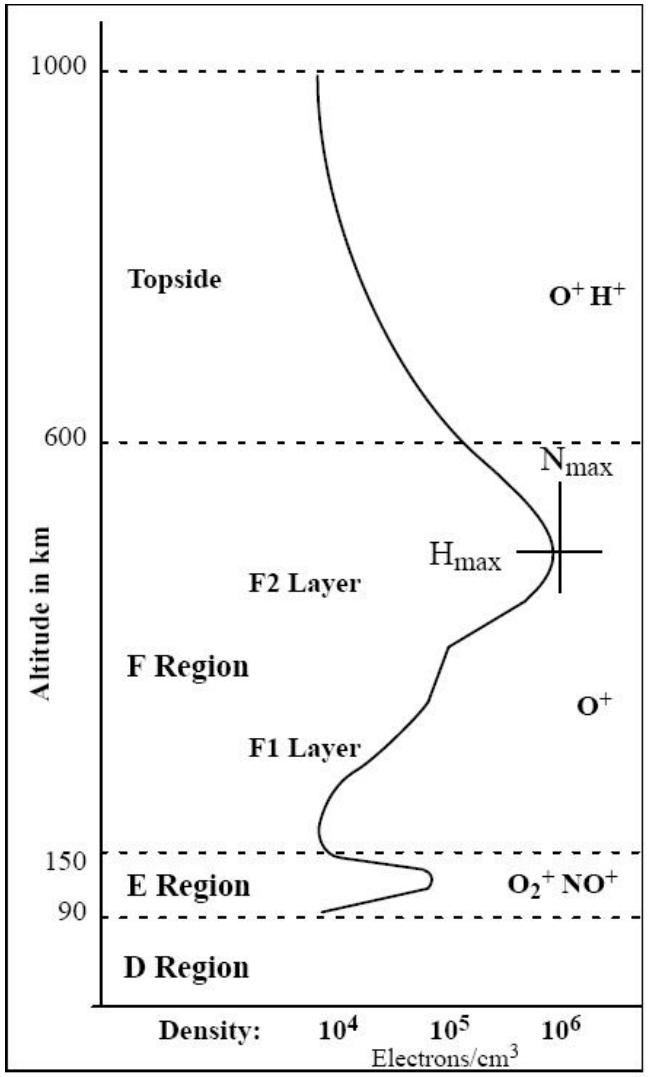


The Sun, Ionosphere, and Radio waves



Ionosphere – Regions

- Different Regions of the Ionosphere
  - **D** (70 - 90 kms, ionized by X-rays 0.1-1 nm)
  - **E** (100 - 120 kms, ionized by EUV 80-103 nm and X-rays 1-20 nm)
  - **F** (forms **F1** and **F2** layers during the day) (ionized by EUV 20-80 nm)



http://www.sel.noaa.gov/info/Iono.pdf

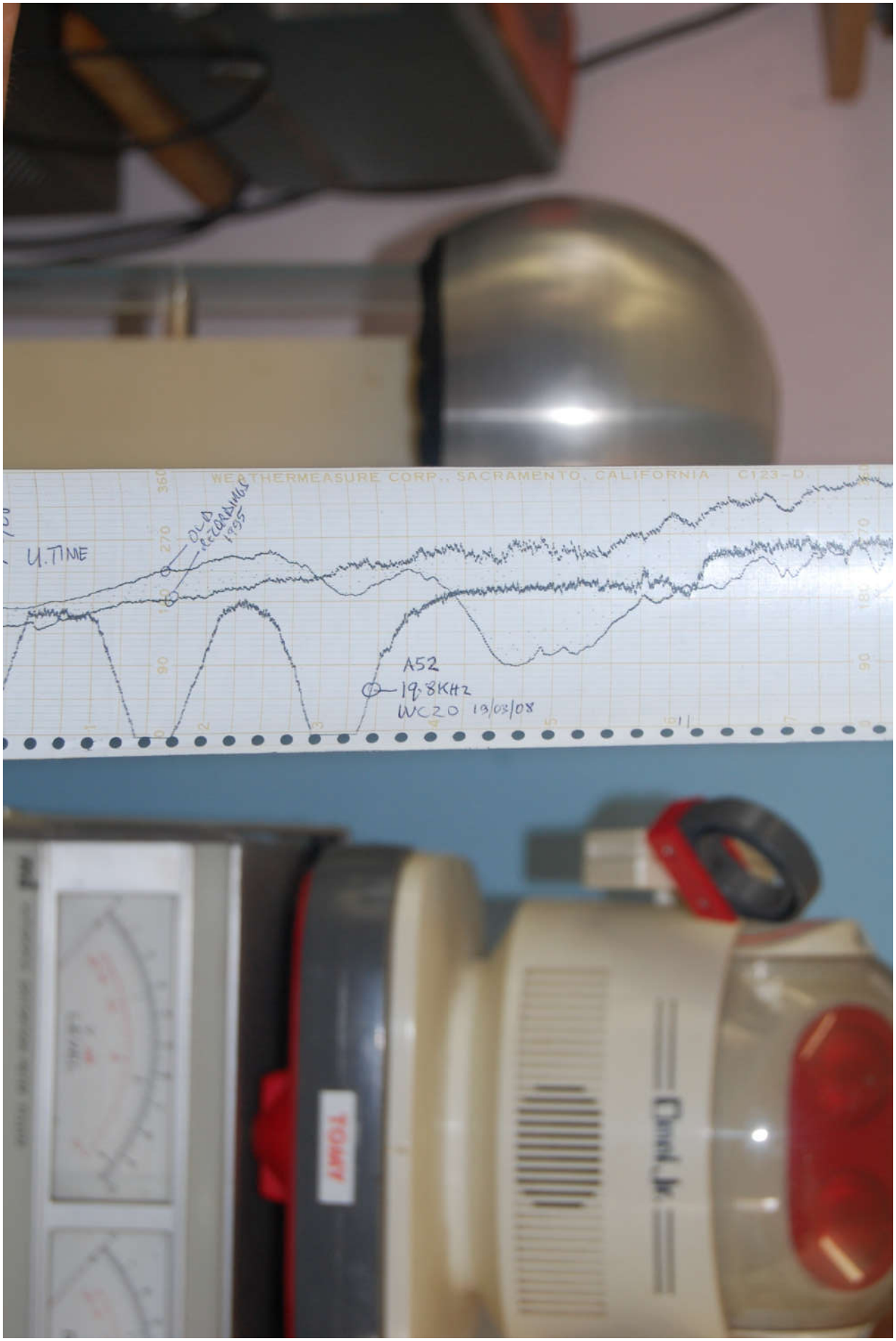

STANFORD
SOLAR
CENTER
Sudden Ionospheric Disturbance
VLF MONITOR
ANTENNA
INPUT
POWER
ON
+5 v
-5 v
AUDIO
(Powered
Speakers)
X1 X5 X10
RF GAIN
ADJUST


E-H-150
OPTICS


PEGELMESSER
LEVEL METER
SIEMENS
ASTRONOMY
Data
Discs

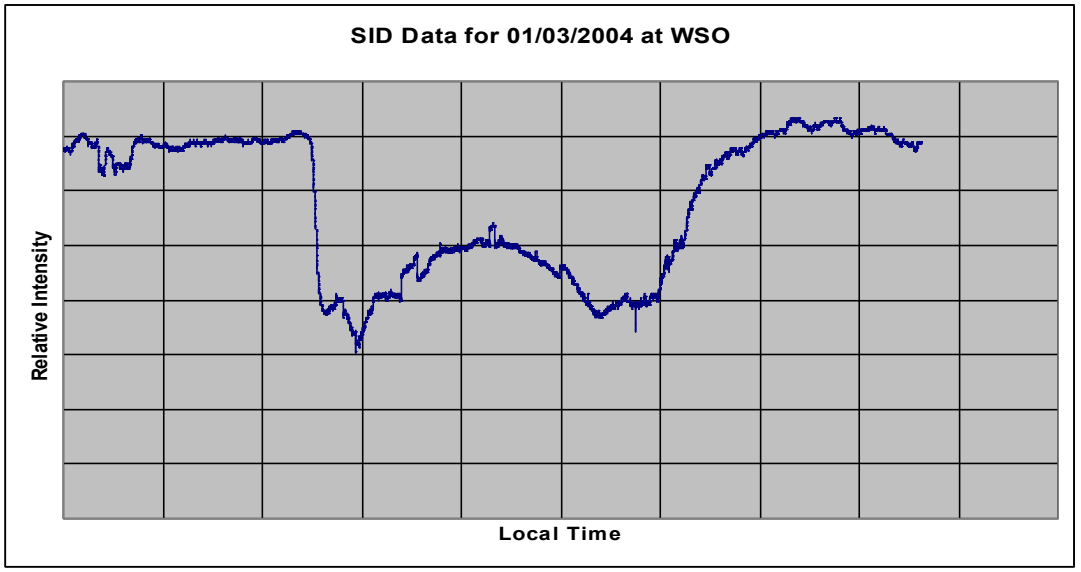

Colour Pack
ROTATRIM


Omni Jr.
TONY
LEVEL
DISTORTION


WESTHERMEASURE CORP., SACRAMENTO, CALIFORNIA
U.TIME
OLD RECORDINGS 1955
A52
19.8KHz
WC20 13/03/08
TOMY

Transmission of VLF through the Ionosphere – regular day

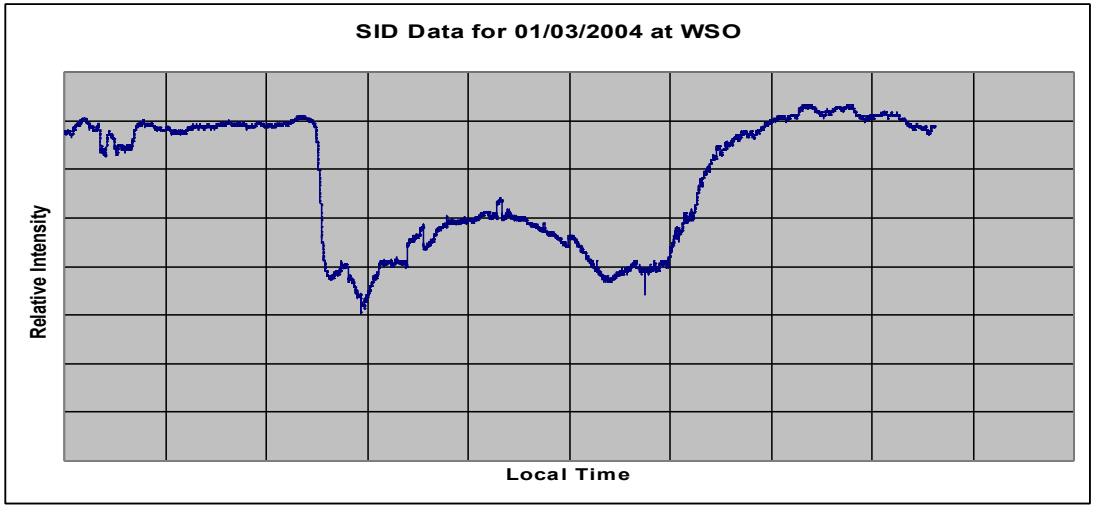
- When VLF transmitted, D layer is unable to reflect the wave as the ion density is not enough
- So penetrates the D-layer, and reflects off the E and F layers
- Loses energy while penetrating the D-layer



Transmission of VLF through the Ionosphere – regular night

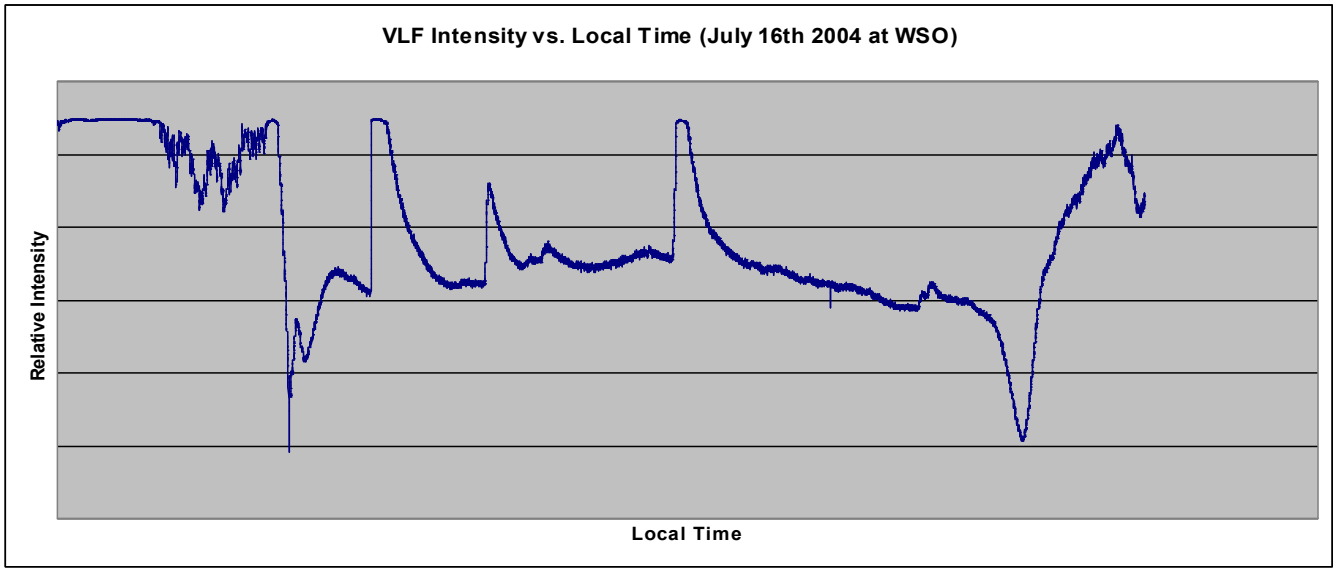
- At night, the D-layer disappears and only the F layer and sporadic E-layers are present

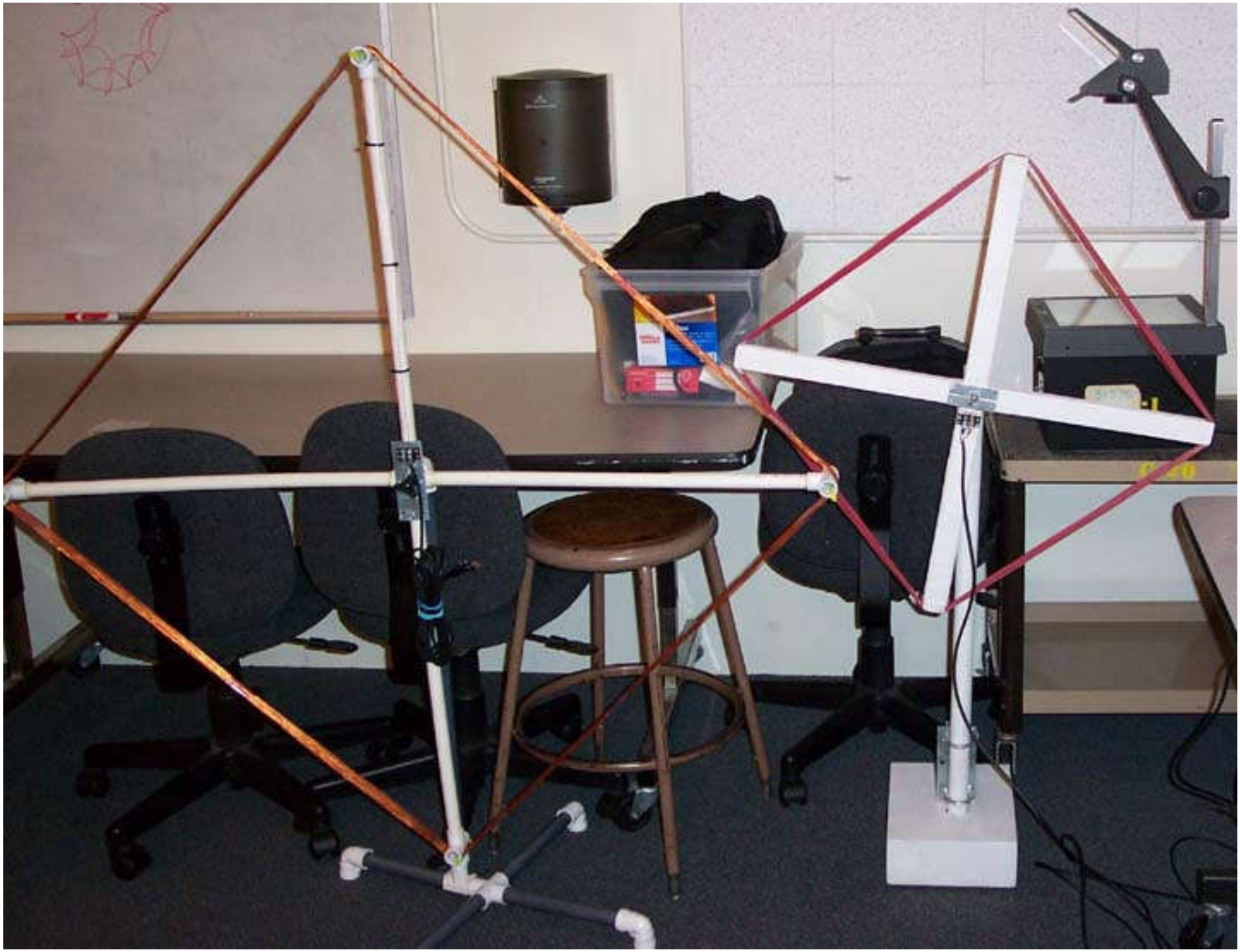
- The signal strength increases as the wave no longer has to go through the D-layer



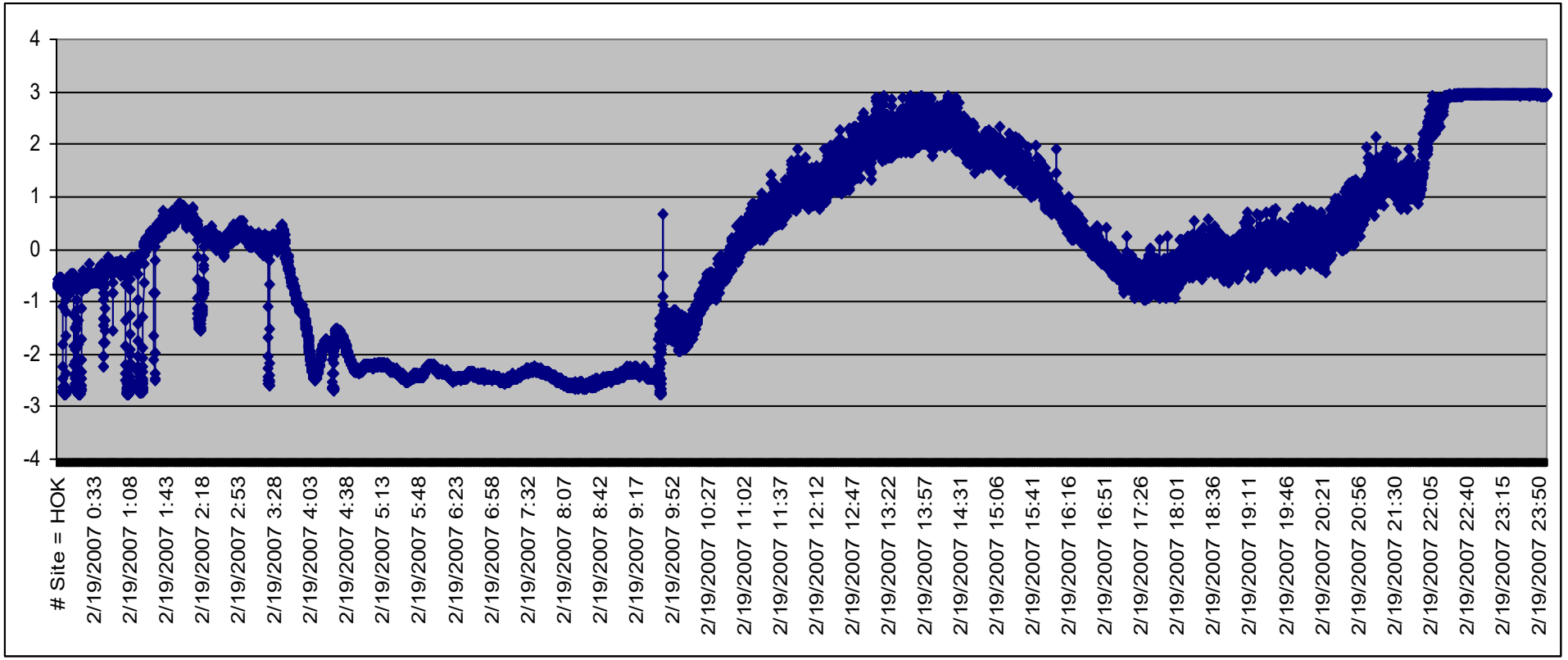
Transmission of VLF through the Ionosphere – during a SID

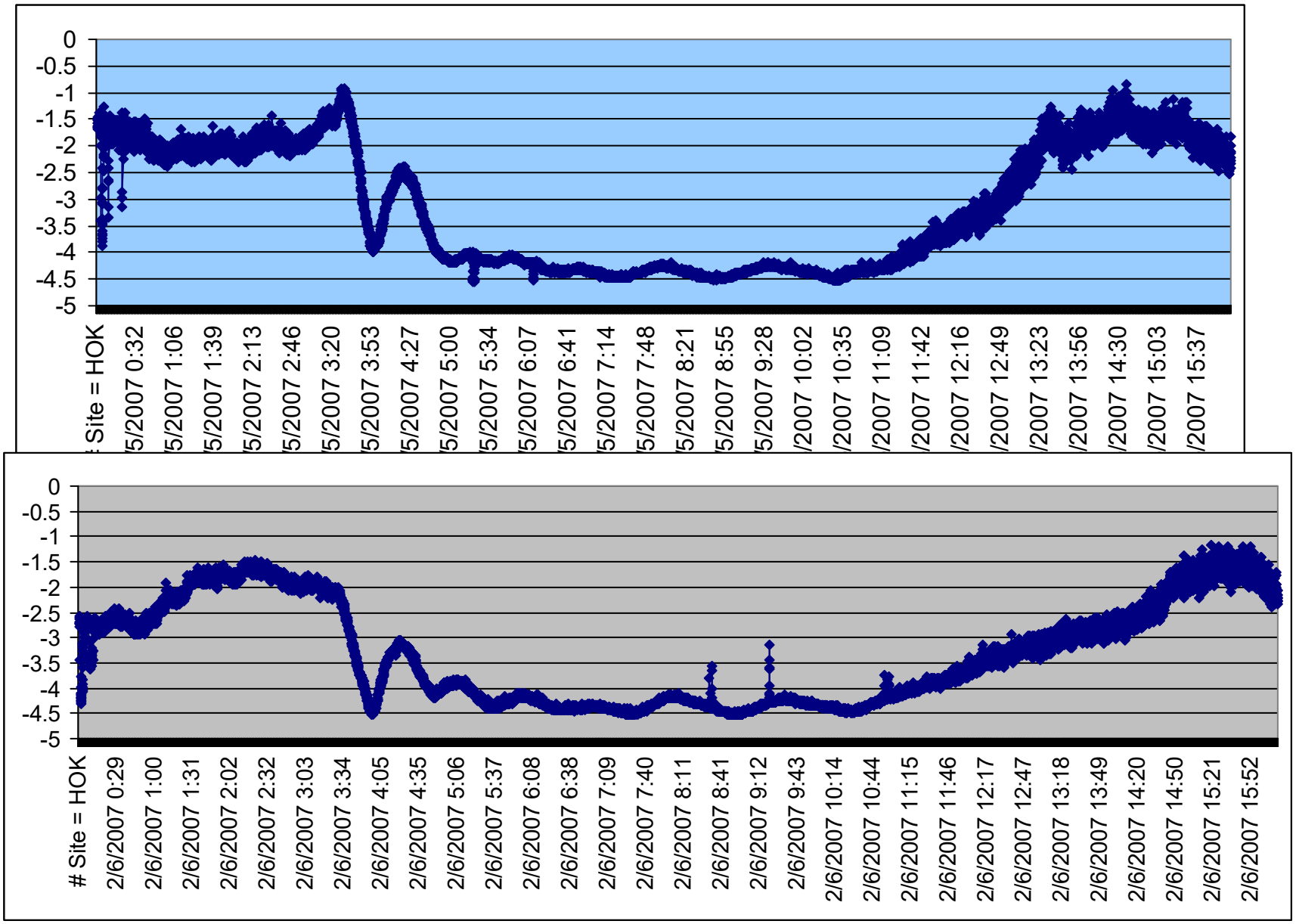
- During a SID, a highly ionized D-layer forms in the Ionosphere
- The ionization is now enough to reflect the VLF
- Moreover, the wave does not have to lose its energy going through an extra ionized layer



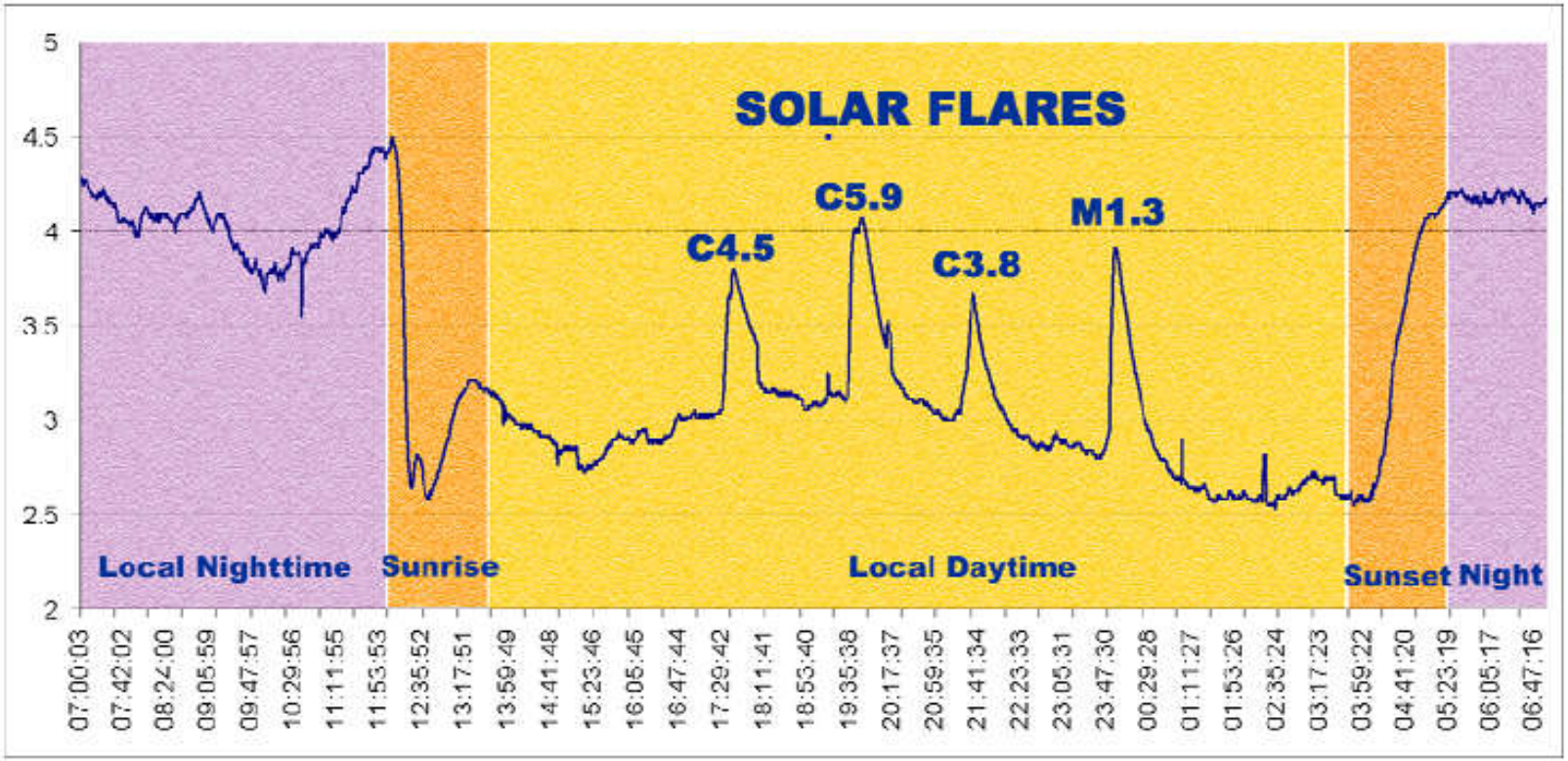



STANFORD
SOLAR
CENTER

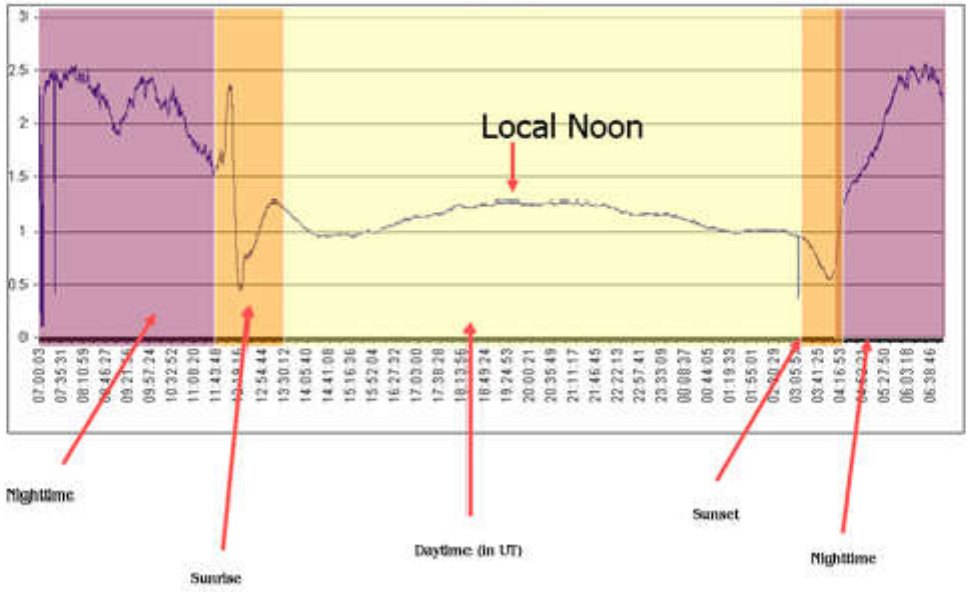

4
3
2
1
0
-1
-2
-3
-4
Site = HOK
2/19/2007 0:33
2/19/2007 1:08
2/19/2007 1:43
2/19/2007 2:18
2/19/2007 2:53
2/19/2007 3:28
2/19/2007 4:03
2/19/2007 4:38
2/19/2007 5:13
2/19/2007 5:48
2/19/2007 6:23
2/19/2007 6:58
2/19/2007 7:32
2/19/2007 8:07
2/19/2007 8:42
2/19/2007 9:17
2/19/2007 9:52
2/19/2007 10:27
2/19/2007 11:02
2/19/2007 11:37
2/19/2007 12:12
2/19/2007 12:47
2/19/2007 13:22
2/19/2007 13:57
2/19/2007 14:31
2/19/2007 15:06
2/19/2007 15:41
2/19/2007 16:16
2/19/2007 16:51
2/19/2007 17:26
2/19/2007 18:01
2/19/2007 18:36
2/19/2007 19:11
2/19/2007 19:46
2/19/2007 20:21
2/19/2007 20:56
2/19/2007 21:30
2/19/2007 22:05
2/19/2007 22:40
2/19/2007 23:15
2/19/2007 23:50


0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
Site = HOK
2/6/2007 0:29
2/6/2007 1:00
2/6/2007 1:31
2/6/2007 2:02
2/6/2007 2:32
2/6/2007 3:03
2/6/2007 3:34
2/6/2007 4:05
2/6/2007 4:35
2/6/2007 5:06
2/6/2007 5:37
2/6/2007 6:08
2/6/2007 6:38
2/6/2007 7:09
2/6/2007 7:40
2/6/2007 8:11
2/6/2007 8:41
2/6/2007 9:12
2/6/2007 9:43
2/6/2007 10:14
2/6/2007 10:44
2/6/2007 11:15
2/6/2007 11:46
2/6/2007 12:17
2/6/2007 12:47
2/6/2007 13:18
2/6/2007 13:49
2/6/2007 14:20
2/6/2007 14:50
2/6/2007 15:21
2/6/2007 15:52

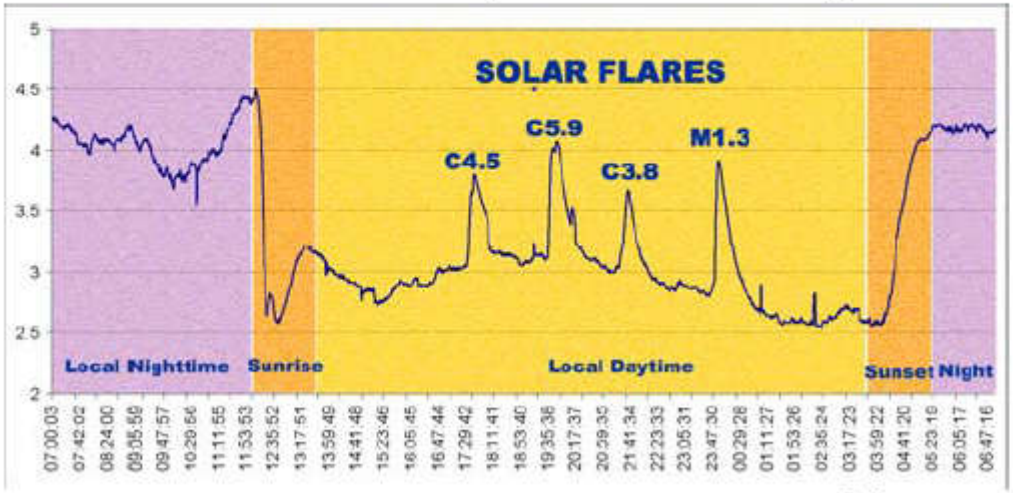
Chapter 4 Data Handling and Analysis



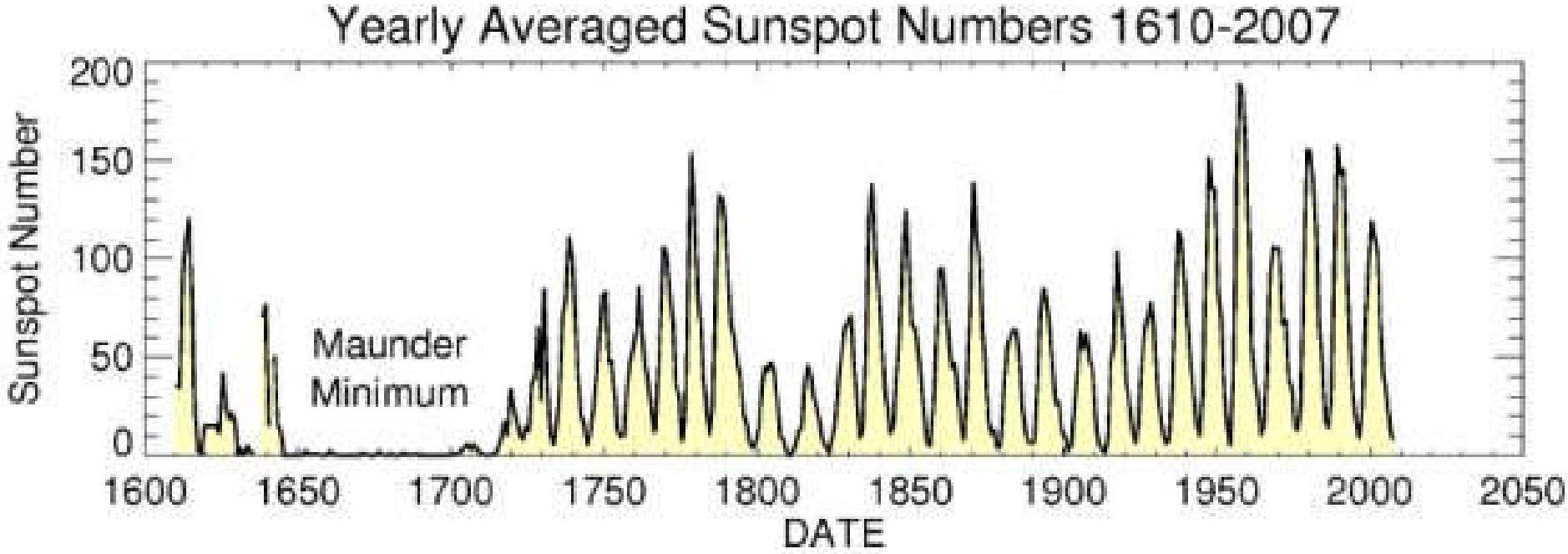
Normal 24 Hr. Day (No flares)



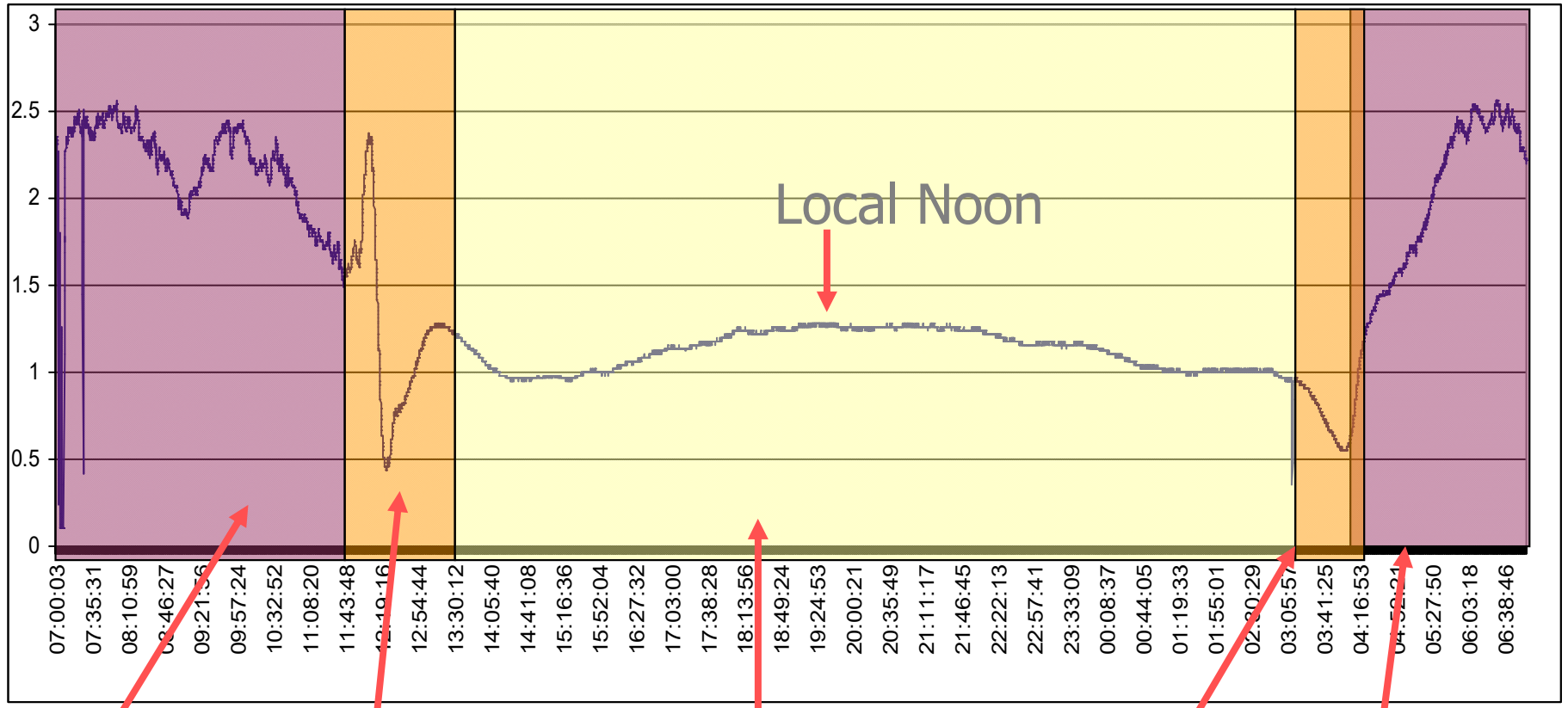
We added the colors, arrows, and labels to help you understand the chart. The chart below shows a similar day but with 4 strong flares:



Note the characteristic change in signal strength, usually a drop, at sunrise and a subsequent return to night values (i.e. rise) at sunset. The spikes on the above graph show ionospheric response to solar


Yearly Averaged Sunspot Numbers 1610-2007
Sunspot Number
200
150
100
50
0
Maunder
Minimum
1600
1650
1700
1750
1800
1850
1900
1950
2000
2050
DATE

Normal 24 Hr. Day (No flares)



Nighttime

Sunrise

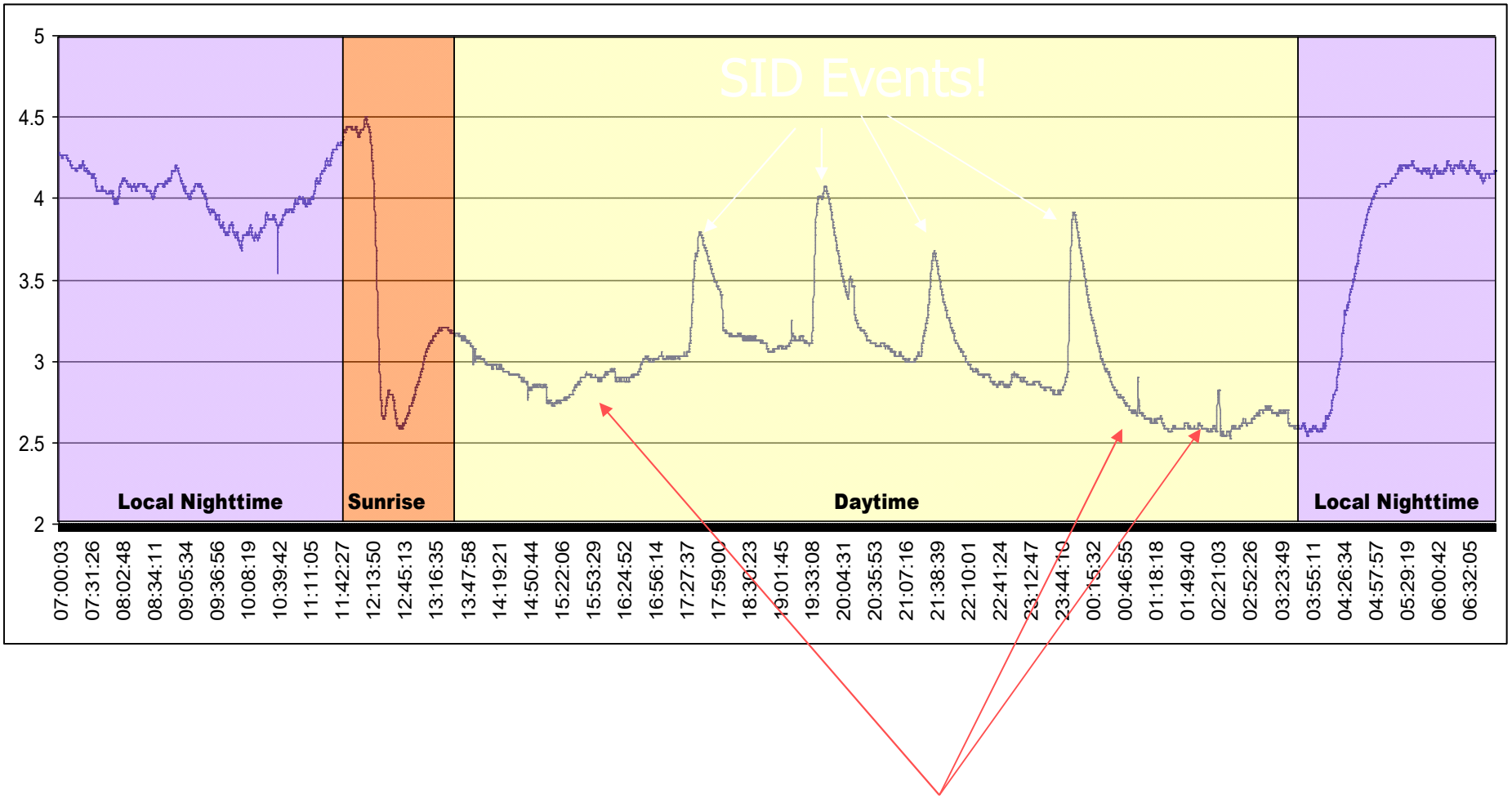
Daytime

Sunset

Nighttime

Time in UT

Detecting Solar Flares – SID(s)



However, not all SID events are explainable. Research is needed to help answer "What are these events?"