PROPAGATION

THE AMATEURS

FRIEND

OR

Enemy

A short course on Propagation

Propagation

What is it?
What causes it?
How does it effect HF Communications
How do we understand the charts
Were do we find the propagation information

What is it?

It is the means of transmitting a signal from Point A to B

Three types of propagation:

Direct Wave
Ground Wave
Sky Wave

Direct Wave is line of sight from point A to B
Think HT to Repeater

Ground Wave follows the curvature of the earth and is
the propagation method for low frequencies including broadcast band to upper limit of about 2 MHz

Sky Wave refracted wave from the ionosphere

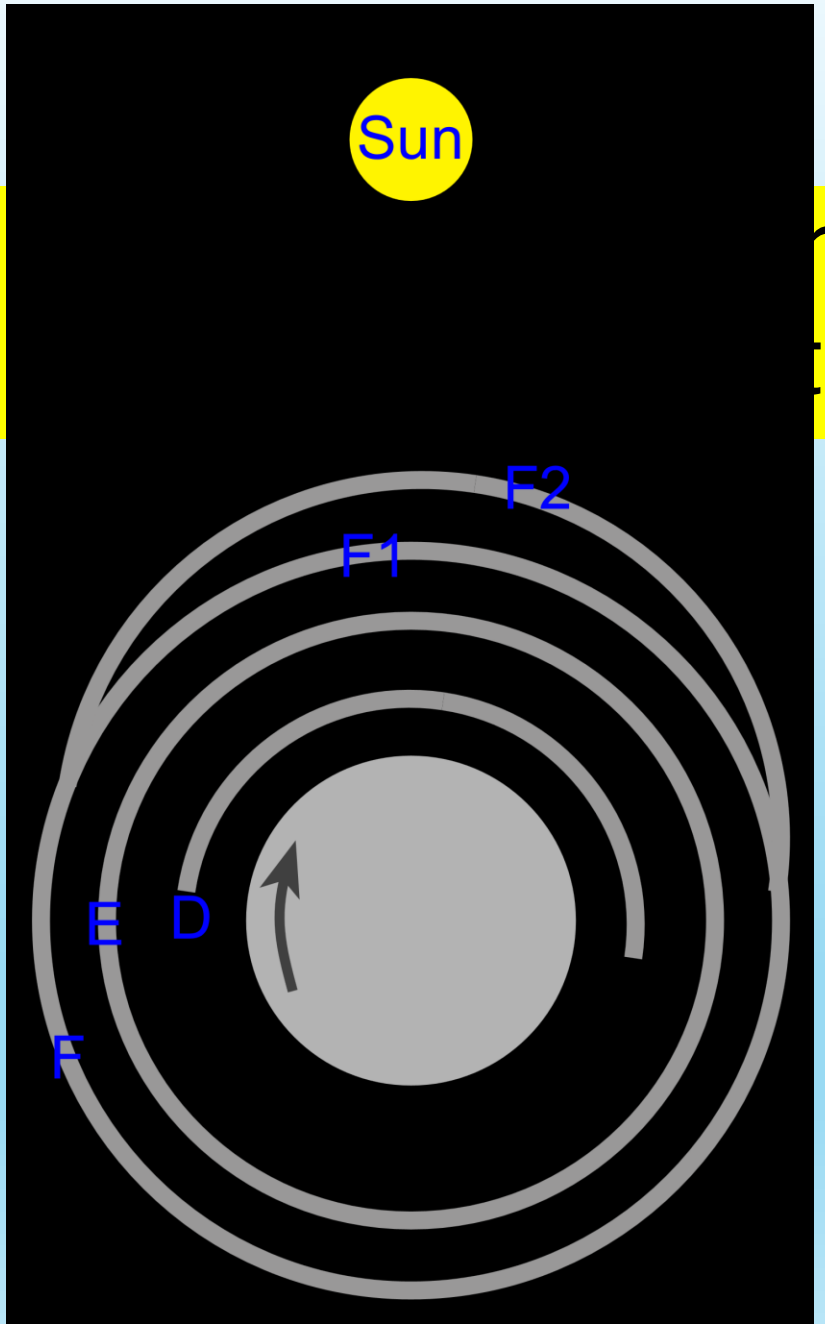
r this presentation we will be discussing Sky Wave only

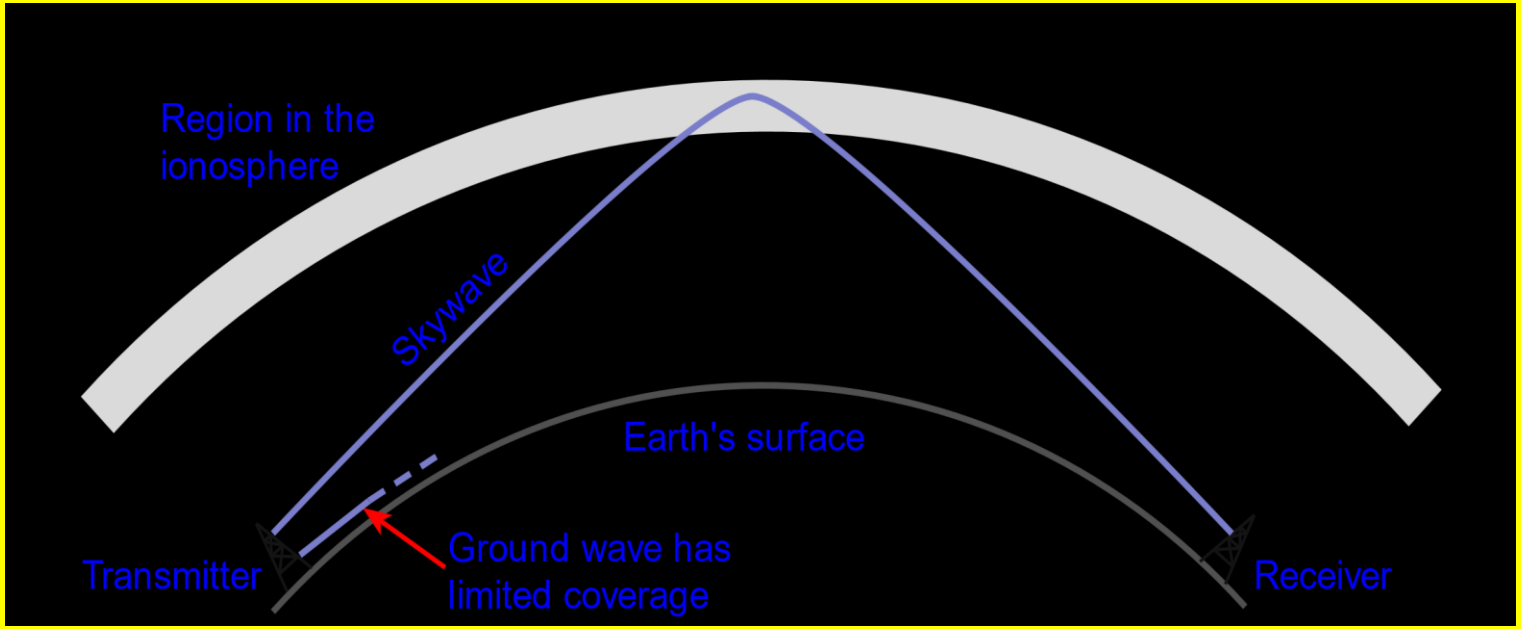
Ionospheric Propagation

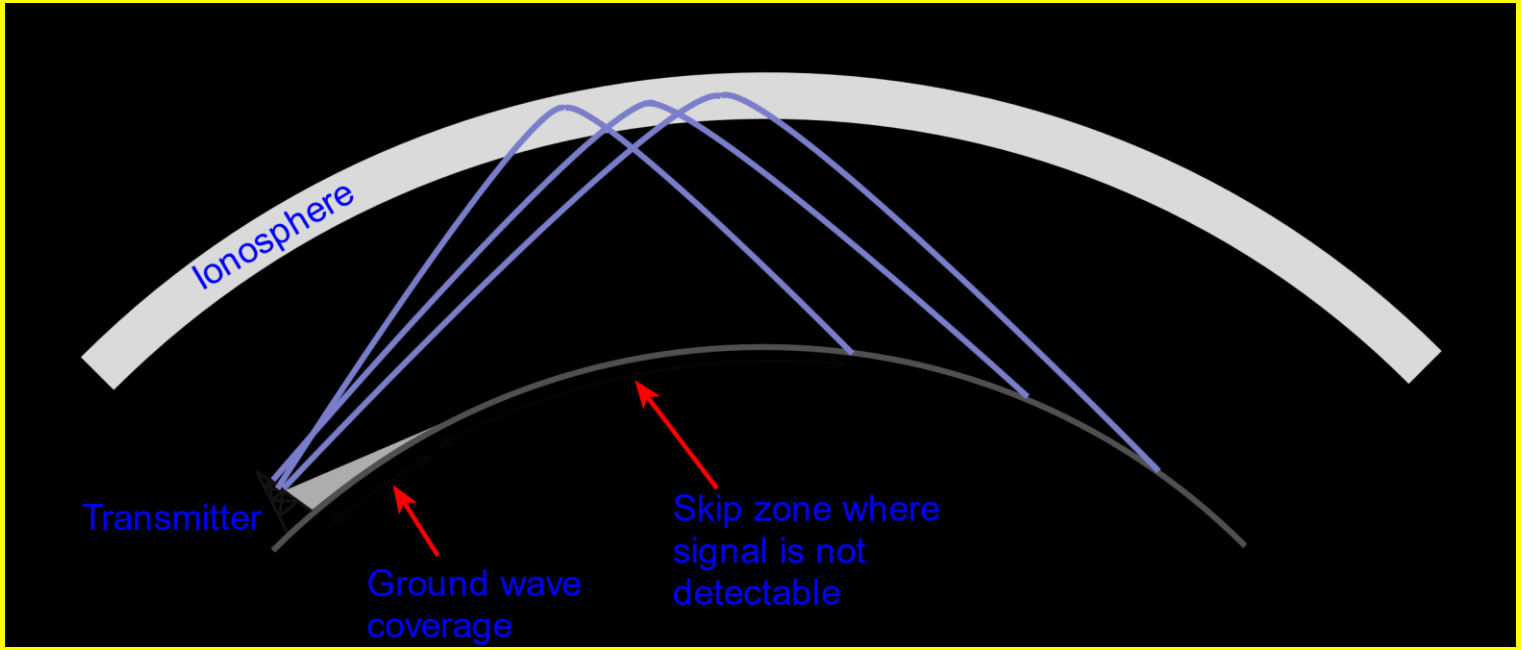
Ionization in the ionosphere is caused mainly by radiation from the Sun. However it is not the ion that causes radio signals to be refracted but the free electron produced when an atom is ionized. The more free electrons per meter squared the better the refraction.

What kind of radiation from the sun causes this ionization? Mostly it's ultraviolet light and X-rays.

The ionosphere nber of refractive and absorptive the D, E, F1 & F2




Region in the ionosphere
Skywave
Earth's surface
Transmitter
Ground wave has limited coverage
Receiver


Ionosphere
Transmitter
Ground wave coverage
Skip zone where signal is not detectable

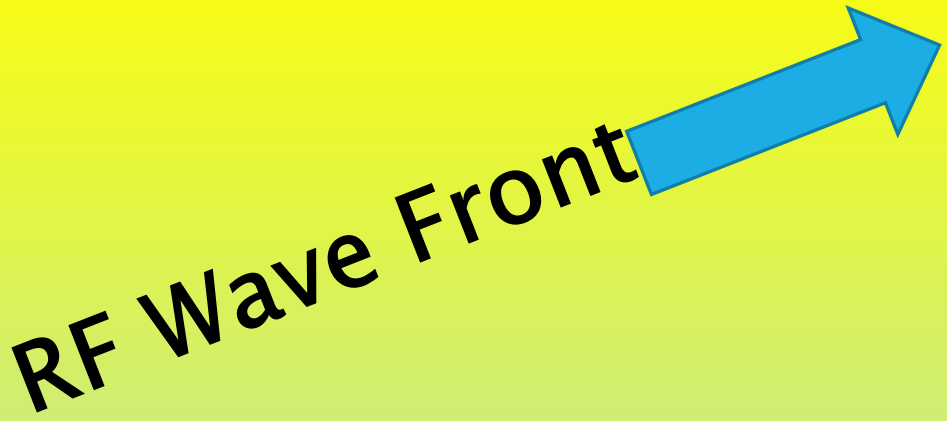
Four important definitions we need to understand

Critical Frequency: The highest frequency that will be reflected
To earth when the transmitted signal is straight up 90 degrees.

Maximum useable Frequency MUF: The highest frequency that can be used to communicate between point A and B. Rule of thumb is that this is 3X the critical frequency for the F layer and about 5X for the E layer.

The Lowest Useable Frequency LUF: The lowest frequency

Optimum working frequency: The best frequency for communications between Point A & B. By rule of thumb to be about 20% below MUF.



The Wave front leaves the antenna as a linear wave either horizontal or vertically polarized.
When it reaches the ionosphere it breaks into two circular polarized waves.
The main wave is right circular and known as the ordinary wave “O”.
The second wave is left circular and known at the extra ordinary wave “X”.
These two waves have slightly different propagation

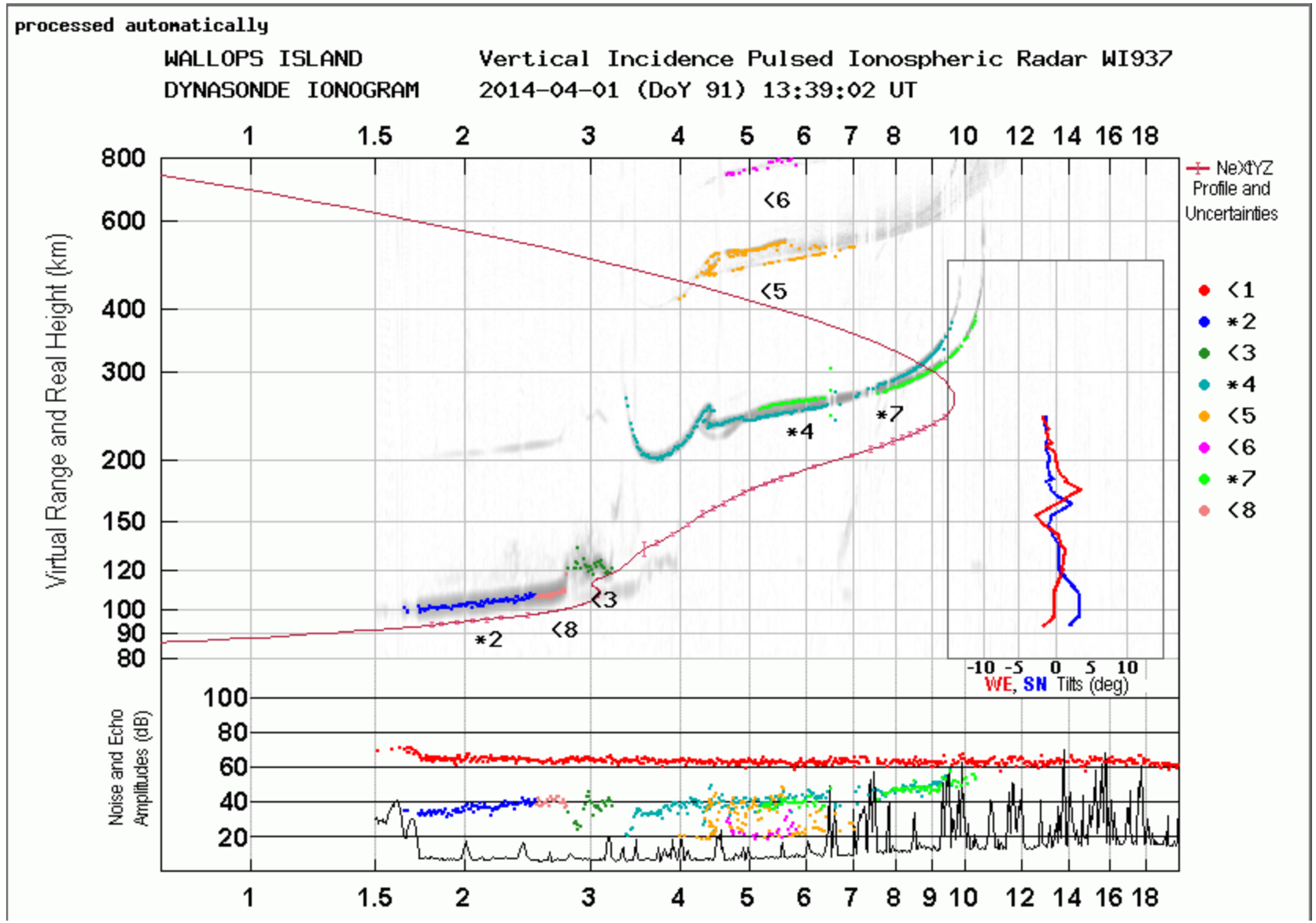
75/80 meters is the band most used for NVIS operation.

WHY

Since this is a 90 degree vertical signal one must operate within the critical frequency window. The critical frequency seldom gets as low as 160 meters or as high as 40 meters except at solar cycle maximum.

Therefore:

The 160M and 75/80m bands are best for NVIS operation.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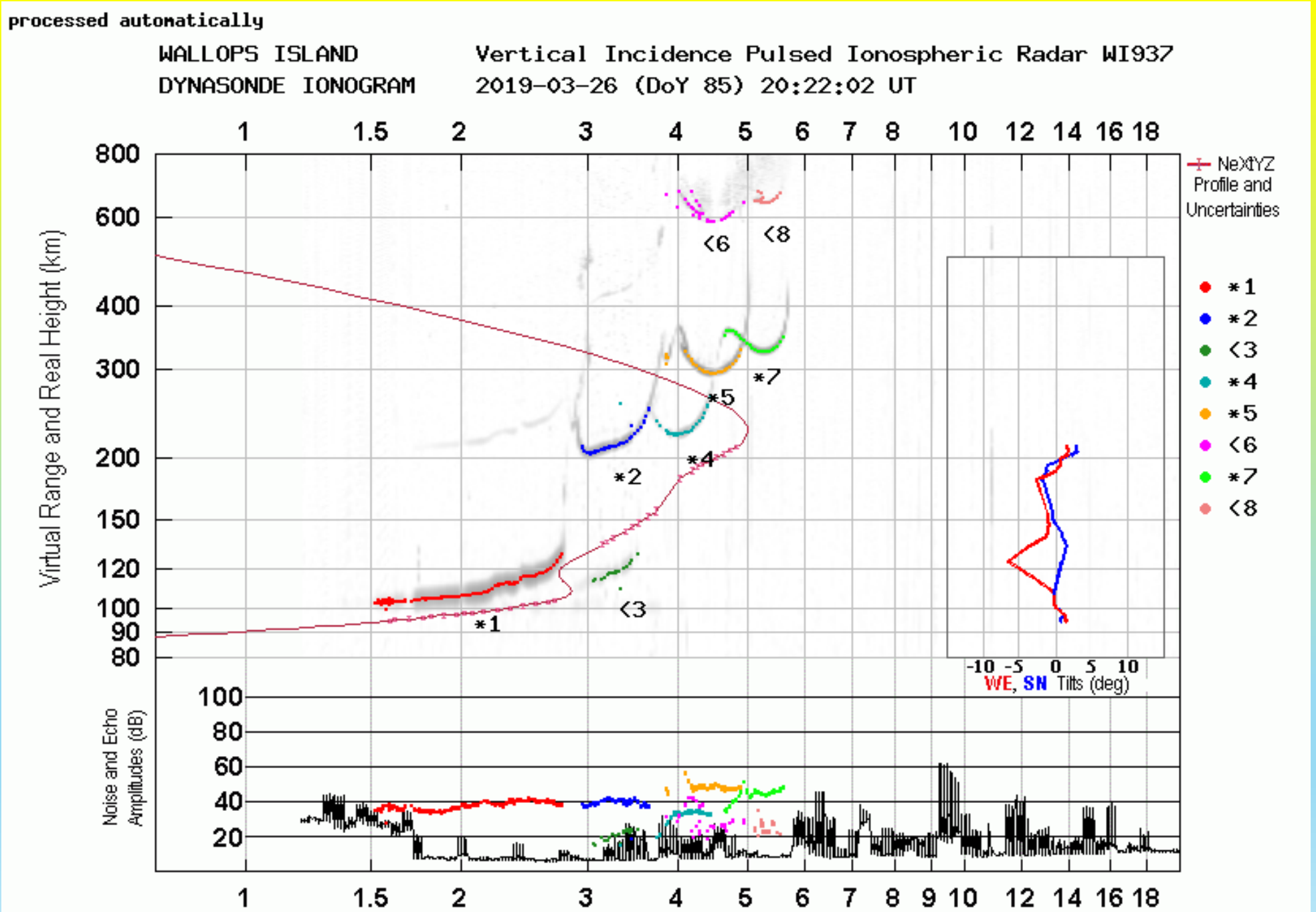
WALLOPS ISLAND
DYNASONDE IONOGRAM
Vertical Incidence Pulsed Ionospheric Radar WI937
2014-04-01 (DoY 91) 13:39:02 UT
Virtual Range and Real Height (km)
Noise and Echo Amplitudes (dB)
NeXtYZ Profile and Uncertainties
<1
*2
<3
*4
<5
<6
*7
<8
WE, SN Tilts (deg)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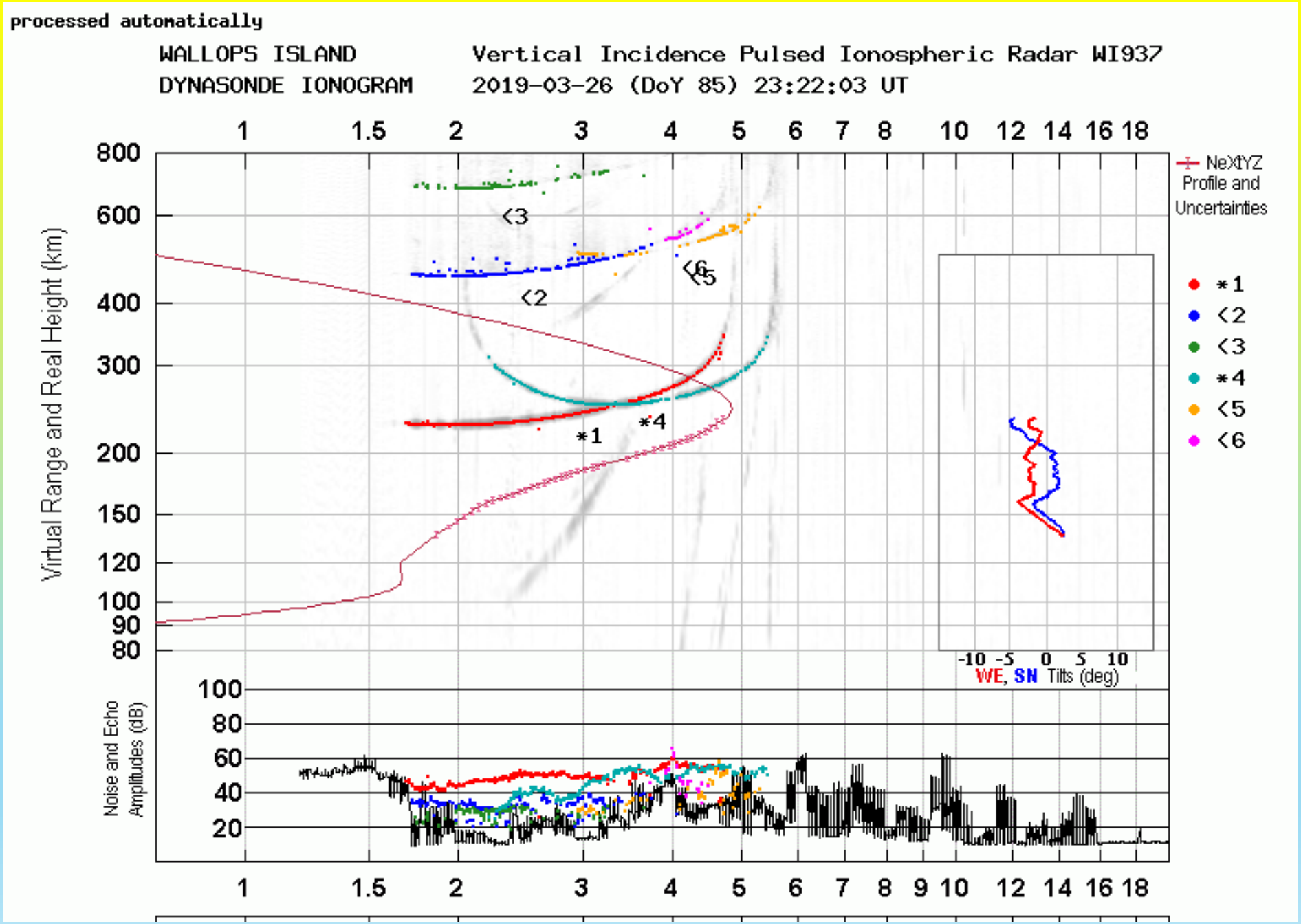
WALLOPS ISLAND
DYNASONDE IONOGRAM
Vertical Incidence Pulsed Ionospheric Radar WI937
2019-03-26 (DoY 85) 20:22:02 UT
Virtual Range and Real Height (km)
Noise and Echo Amplitudes (dB)
NeXtYZ Profile and Uncertainties
*1
*2
<3
*4
*5
<6
*7
<8
-10 -5 0 5 10
WE, SN Tilts (deg)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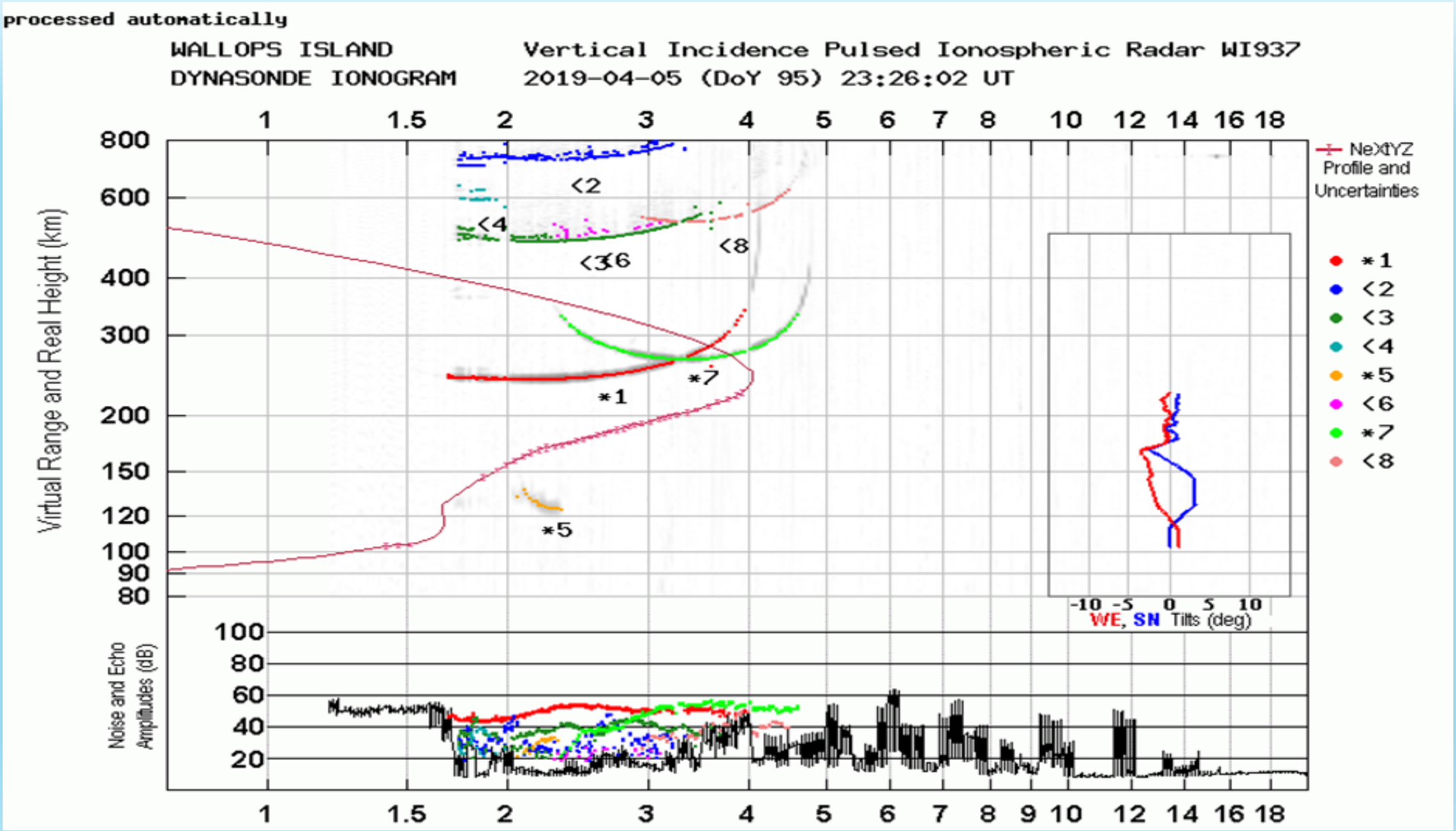
WALLOPS ISLAND
DYNASONDE IONOGRAM
Vertical Incidence Pulsed Ionospheric Radar WI937
2019-03-26 (DoY 85) 23:22:03 UT
Virtual Range and Real Height (km)
Noise and Echo Amplitudes (dB)
WE, SN Tilts (deg)
NeXtYZ Profile and Uncertainties
*1
<2
<3
*4
<5
<6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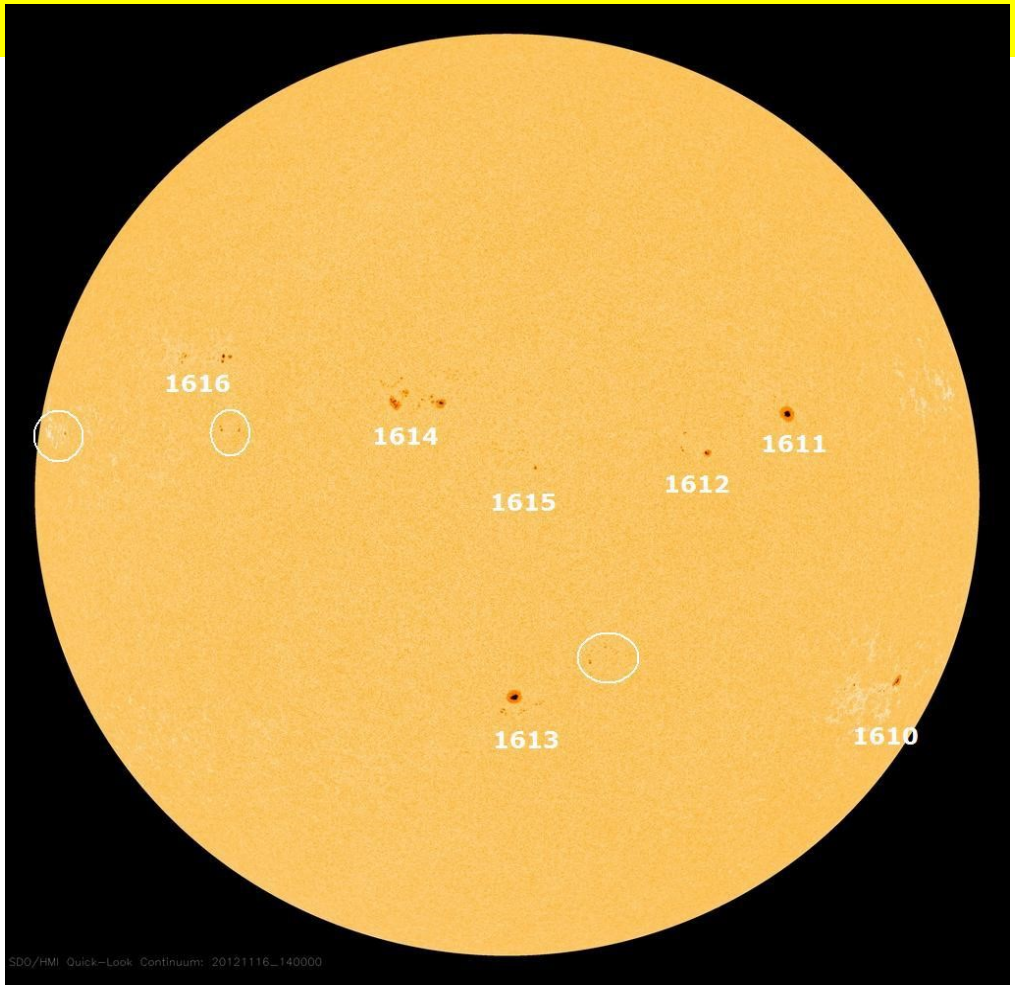
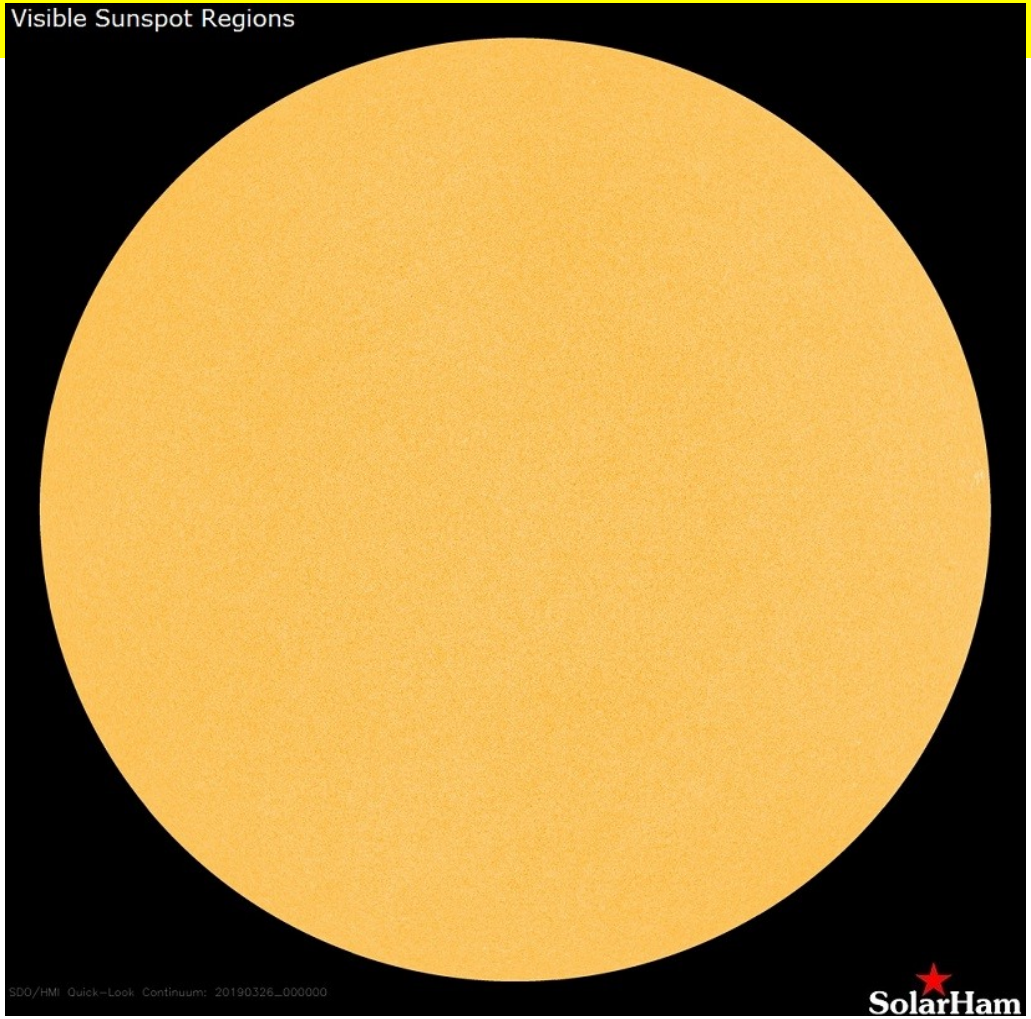
WALLOPS ISLAND
DYNASONDE IONOGRAM
Vertical Incidence Pulsed Ionospheric Radar WI937
2019-04-05 (DoY 95) 23:26:02 UT
Virtual Range and Real Height (km)
Noise and Echo Amplitudes (dB)
NeXtYZ Profile and Uncertainties
*1
<2
<3
<4
*5
<6
*7
<8
WE, SN Tilts (deg)

SUN IN 2012


1616
1614
1611
1612
1615
1613
1610
SDO/HMI Quick-Look Continuum: 20121116_140000

THE SUN AT THE PRESENT—NO SPOTS



DATA WE NEED TO KNOW

Solar Flux “SFI”: Measure of solar radiation at 10.7 cm. Higher the better Seldom below 68.

Sun Spot Number “SN”: Higher the better.

Solar Wind “Kps”: Lower the better.

foE: Critical frequency of E layer

Fof2: Critical frequency of F layer

MUF: Maximum useable frequency

K index: Geomagnetic field measurement taken every 3 hours. Lower the better.

A index: average of 8 previous K index.

WHERE DO WE GET IT?

http://Solarham.com Excellent source of most of the indices.

http://surf.colorado.edu/login.dcc Source of ionograms – Need permission to use but not hard to get. Initial page will have the current ionogram.

https://www.hfunderground.com/propagation/ Lots of info

https://www.swpc.noaa.gov/ Likewise

https://www.qrzcq.com/dxcluster World wide DX cluster

http://www.wm7d.net/hamradio/solar/

http://www.hamqsl.com/solar.html

WHAT IS THE BEST STUDY GUIDE ON PROPAGATION?

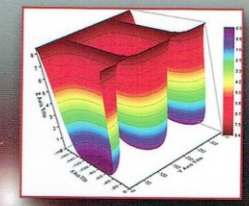
Propagation and Radio Science

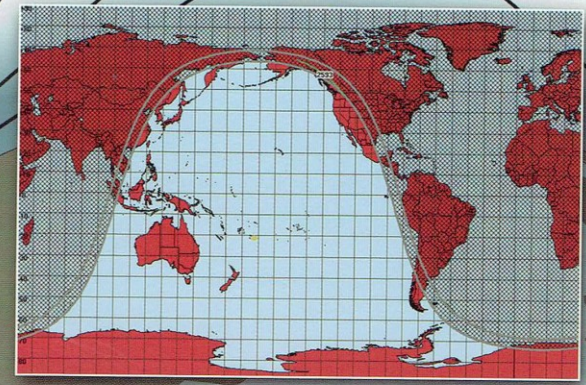
From the ARRL Bookstore

Propagation and Radio Science

Exploring the Magic of Wireless Communication

by Eric P. Nichols, KL7AJ






The End
Go and excite some electrons