



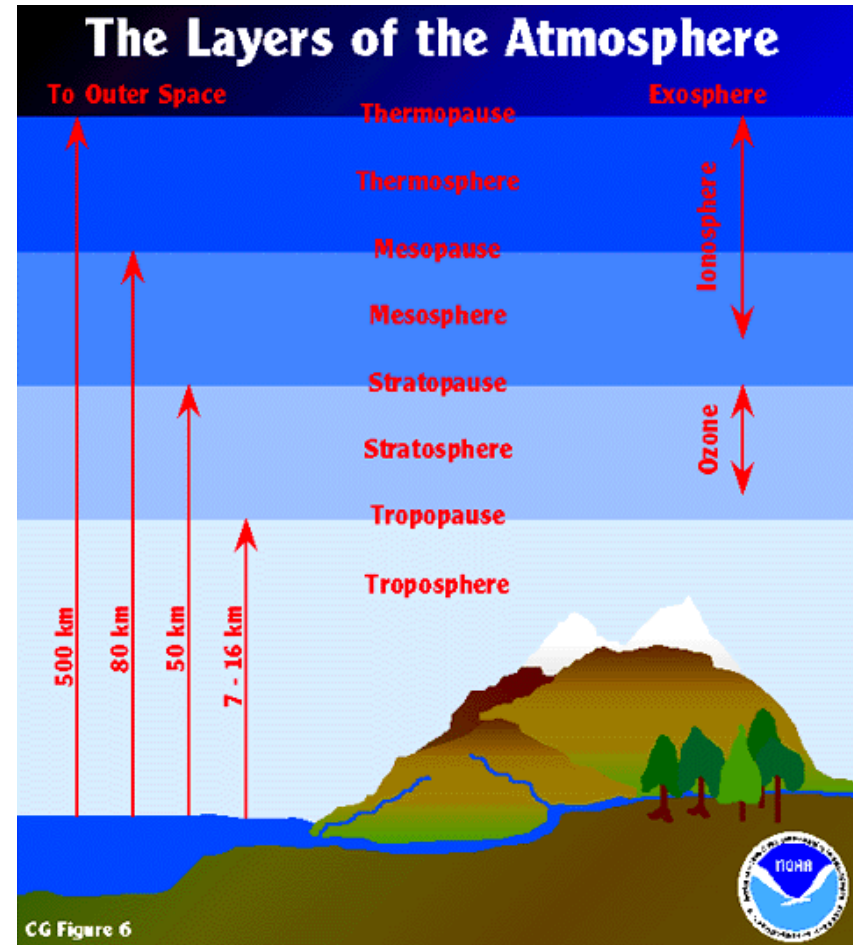
Space Weather and Propagation

MARTIN BUEHRING -KB4MG

Why know about Space Weather?

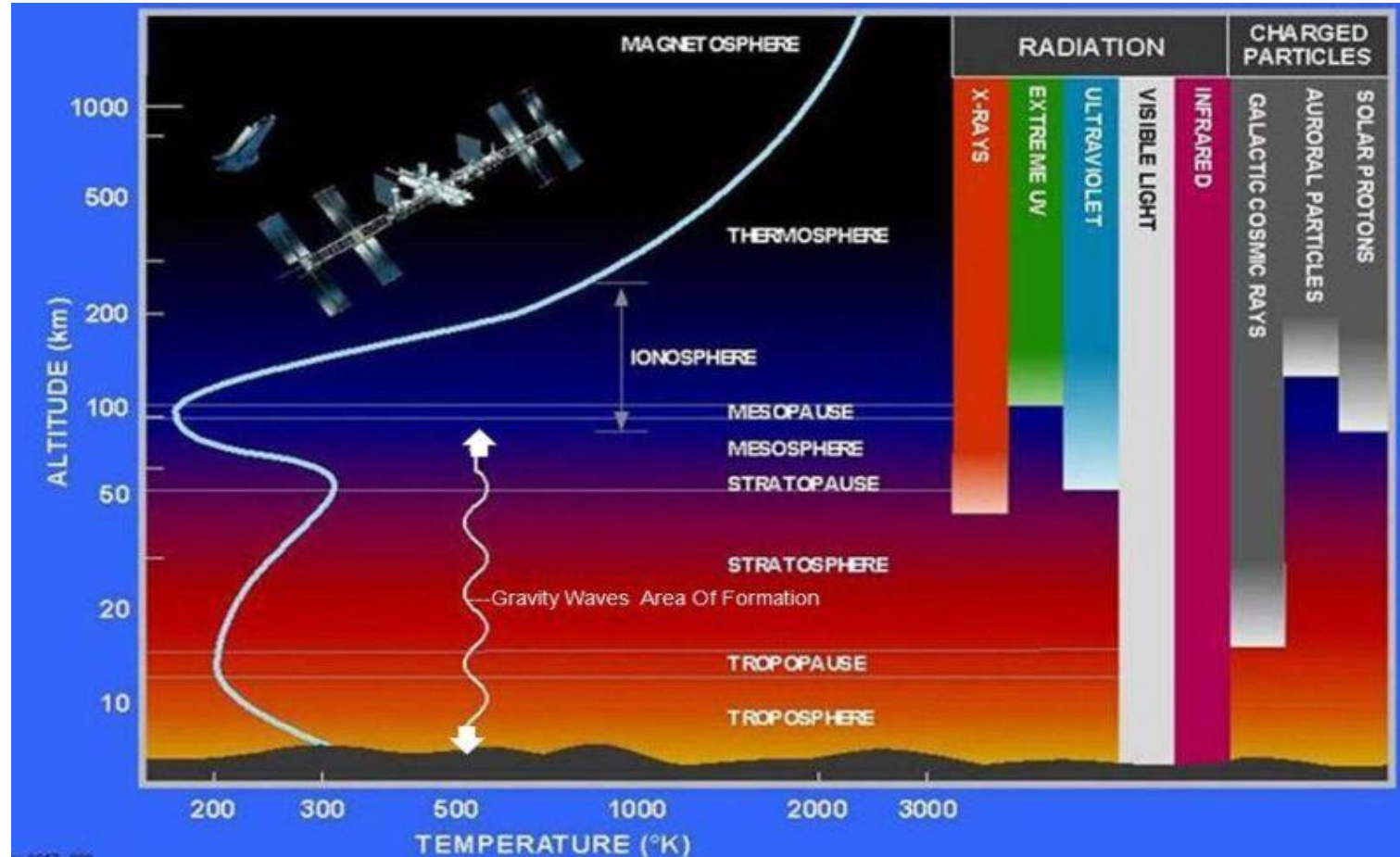
- Our SUN has an enormous affect not only on our climate, but on the upper atmosphere that surrounds us, and protects us.
- Knowing about space weather and the layers of the atmosphere helps us to understand radio propagation and radio blackouts.
- With just a little knowledge, we can know what is the best use of our time and energy when it comes to Ham Radio.
- Even more knowledge can help us to get the best results on the bands we are able to operate in.

80Km = 50 miles 500Km = 300 miles



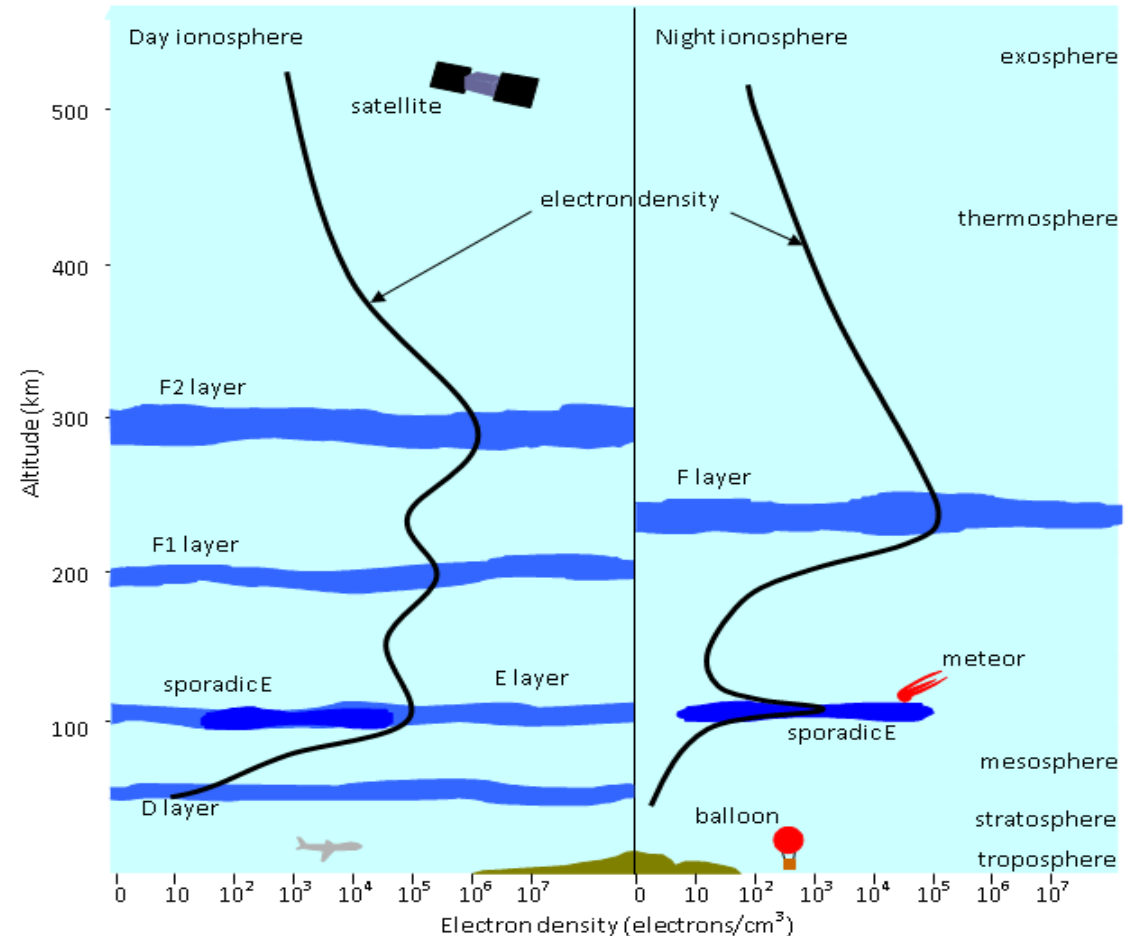
What is the ionosphere?

- A layer of our earth's atmosphere that ranges from 80 to 500 Km (50 mi – 300 mi) high.
- It is an area of charged plasma consisting of ions and electrons and can carry currents.
- It would be electrically neutral if not for UV radiation from the sun.
- The more radiation that impacts it the more reflective it becomes to a certain range of electromagnetic waves (radio waves).

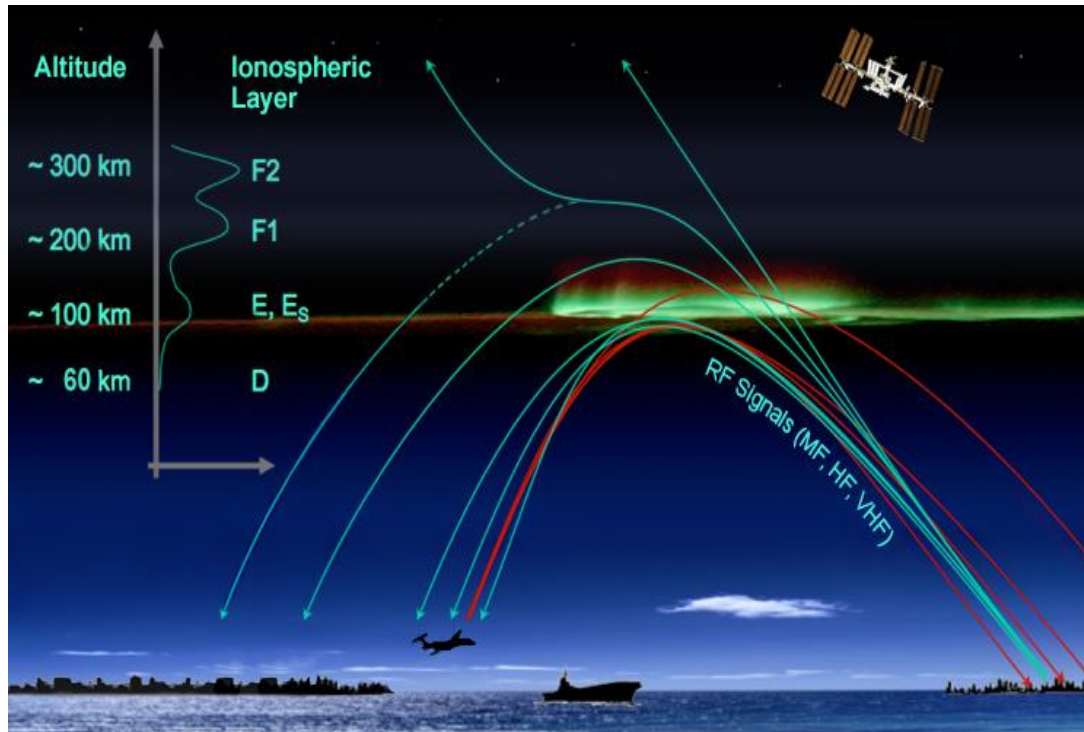


Layers of the ionosphere

- Ionosphere is made up of 3-4 layers
- Not a smooth mirror – more like those Fun House mirrors
- Each of these play a role in understanding radio propagation
- Lowest layer D only in daylight time
- E layer – Day time and sometimes at night
- F layer – Breaks into two parts in the day and merges into a single layer at night
- Notice the electron density at the layer boundaries. This is what provides radio propagation

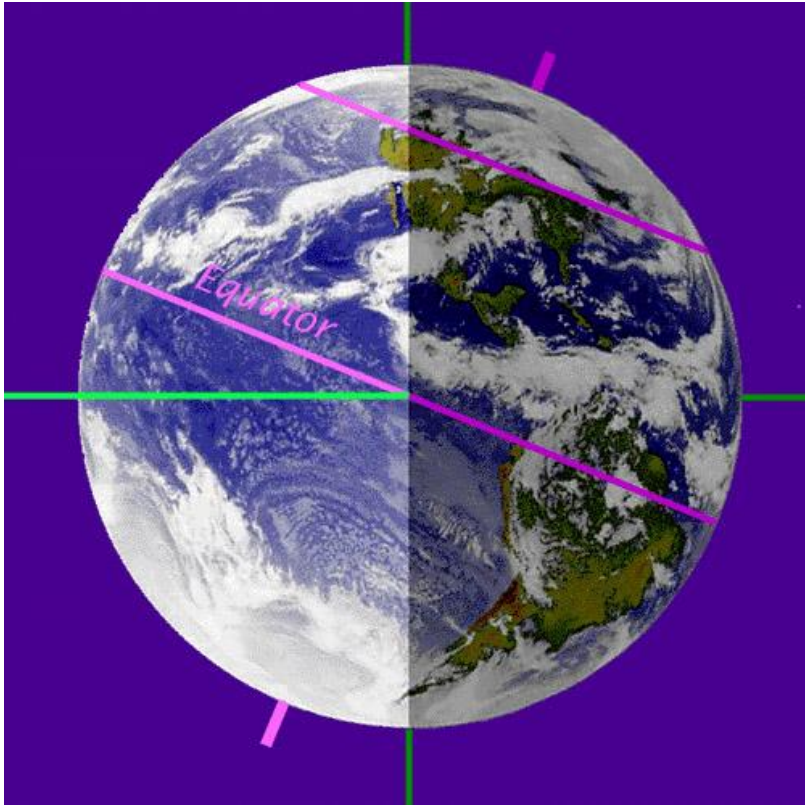


Radio Propagation and layers



- D Region: Closest to the earth and least ionized and is responsible for short hop HF communication.
- E Region: Daylight absorption of MF and HF.
 - Can be useful for single hop HF out to 1200 miles. VHF skip can exist with “sporadic E” (more later).
- F Region: Most responsible for DX.
 - In the daytime, this layer splits into two parts: F1 and F2. After sunset, this layer combines into one.
 - The F2 Region is primarily responsible for long hops or skip to 2500 miles. F2 reaches its maximum height at noon during the summer.

Variations in the Ionosphere



Day –Night

- Because of variation in the temperature of the earth's surface, the distances between the ionospheric layers will change and combine.

Seasonal

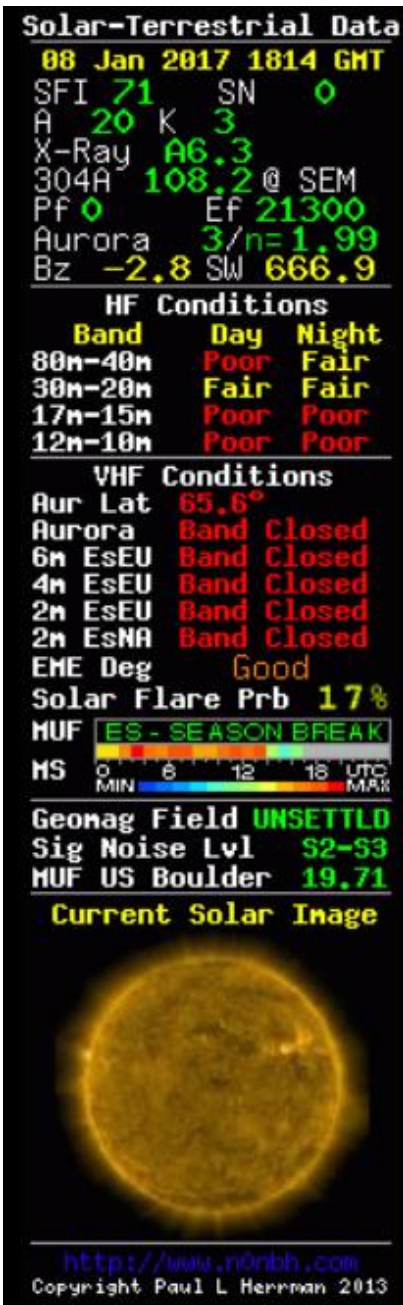
- The hot temperatures of the summer season will energize the atmosphere and warmup the layers creating static and pushing the layers to higher altitudes.

Geographical

- The location of the land mass and the height above sea level will greatly effect propagation both positively and negatively.

Cyclic

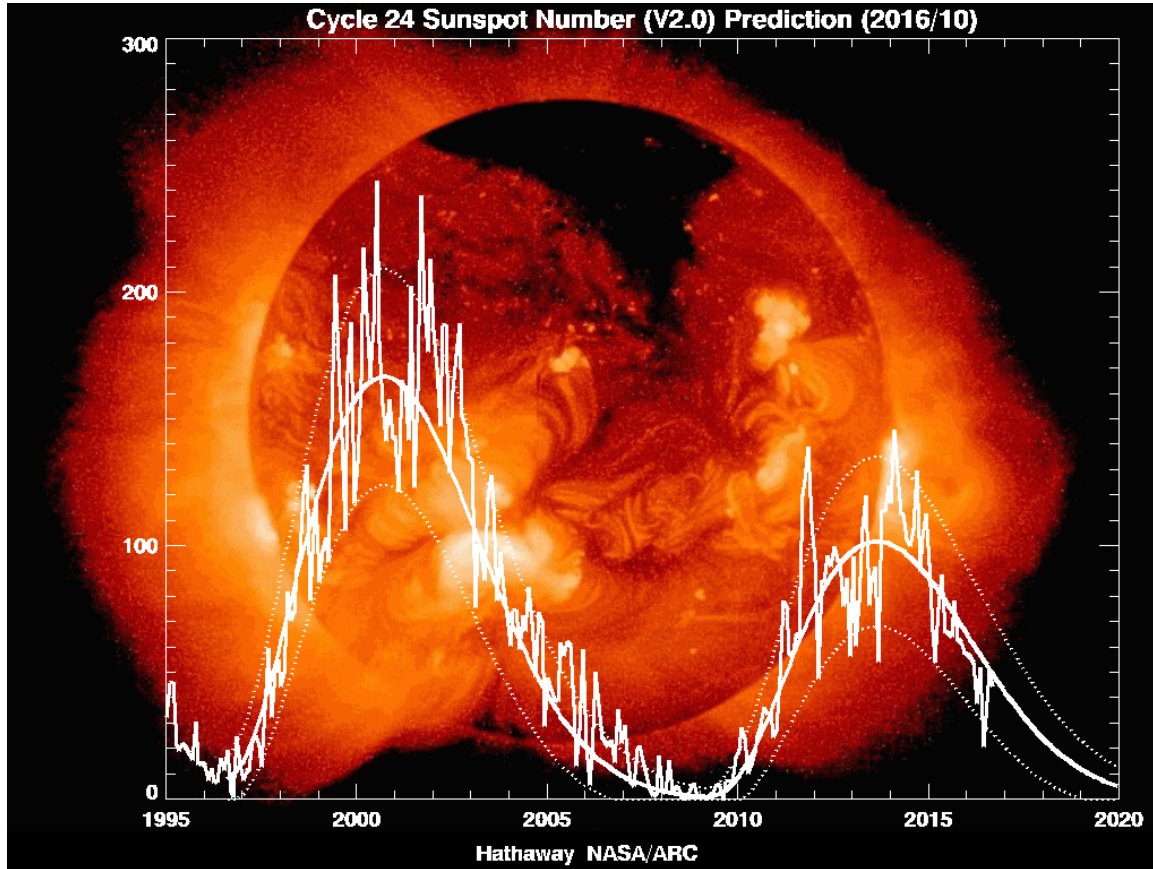
- Because of the effects of the sunspot cycle, propagation will vary every 11 years.



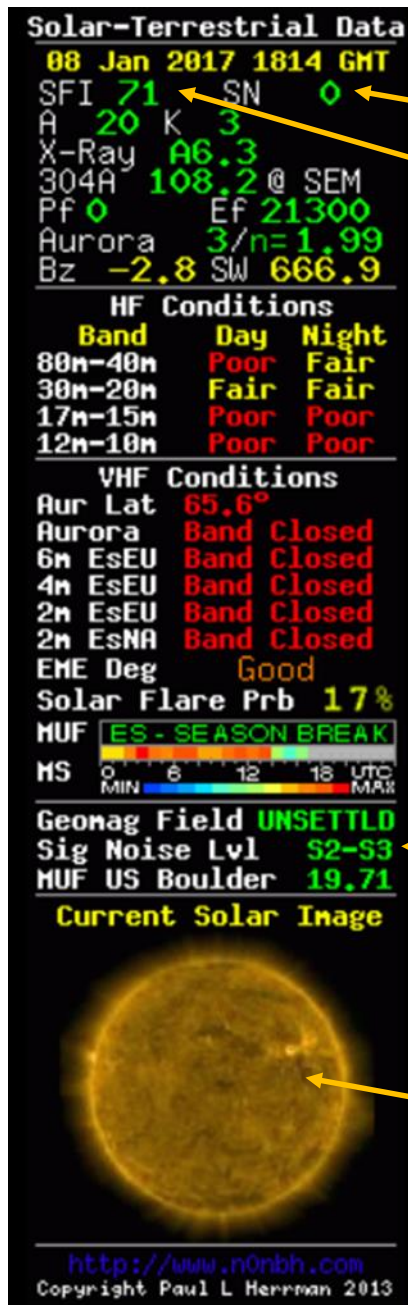
Propagation Prediction

- Commonly seen panel on various Ham Radio sites, like QRZ.com
- Gives you band propagation forecasts based on space weather conditions, but what does it all mean?
- Only give you an average of what the ionosphere is doing for propagation in a range of frequencies.
- What numbers are most important for Ham Radio?
 - SFI – Solar Flux Index (> 90 is good)
 - SN – Sunspot numbers (indicating activity) (anything > 0 is a good sign)
 - MUF – Maximum Usable Frequency (Varies based on location and SFI)

11 year Sunspot Cycle



- The sun's activity runs in 11 year long cycles.
- Not an exact cycle, but it 11 on average
- At the peak of the cycle, solar flux (SFI) is at maximum levels.
- SFI and high number of sunspots produces the best radio propagation



SN = Sunspot
Number

SFI = Solar Flux
Index

Amateur Radio
Band Conditions

Avg noise
level

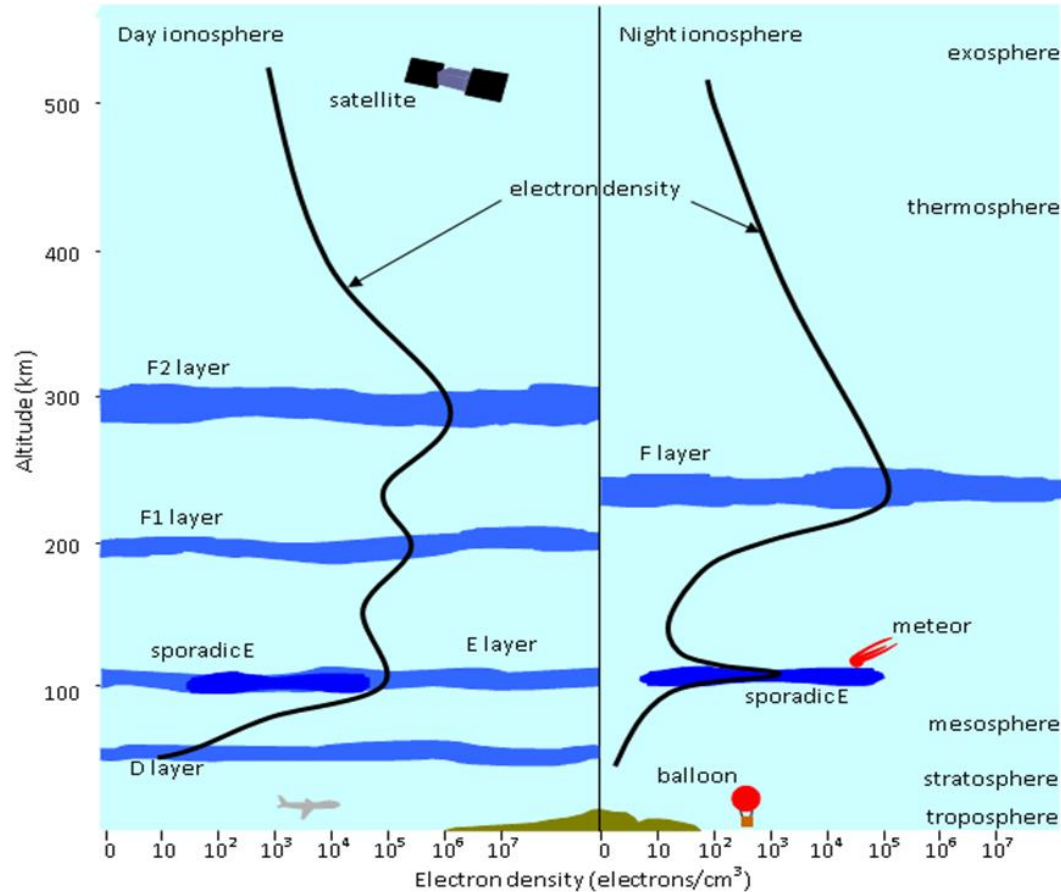
MUF @
Boulder, CO

Earth facing
Disc image

Solar data

- Collected from NOAA
- Often presented on various amateur radio web sites in ways we can use it best
- We are approaching a solar minimum in cycle 24, expected in 2020.
- Propagation will be challenging but not impossible, but knowing what to look for will improve your chances.
- VHF and UHF is largely unaffected

Sporadic E Propagation



- The cause of sporadic E is not completely known, but the most popular theory relates to wind shear at 100km altitude.
- When this occurs, E reflections are almost “mirror-like” and can result on spectacular DX on QRP –especially on VHF and UHF.
- Monitoring distant NOAA weather stations is a good way to measure it’s occurrence.

Solar Minimum? What are we to do?



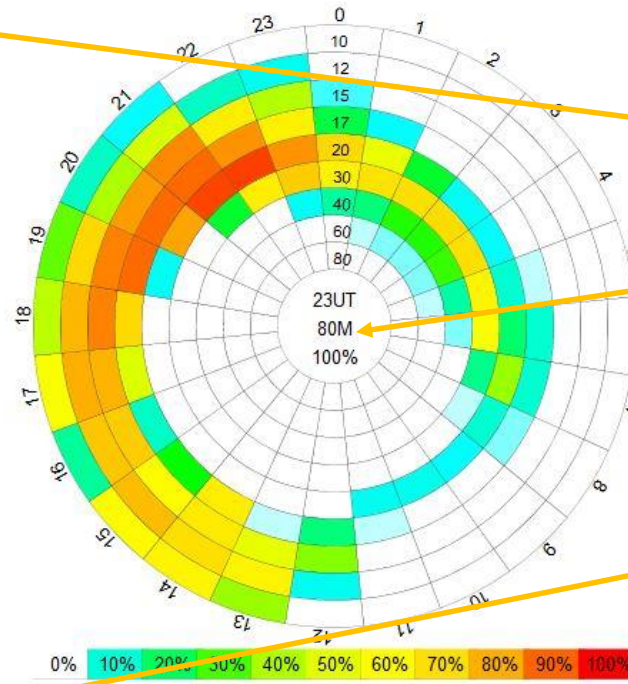
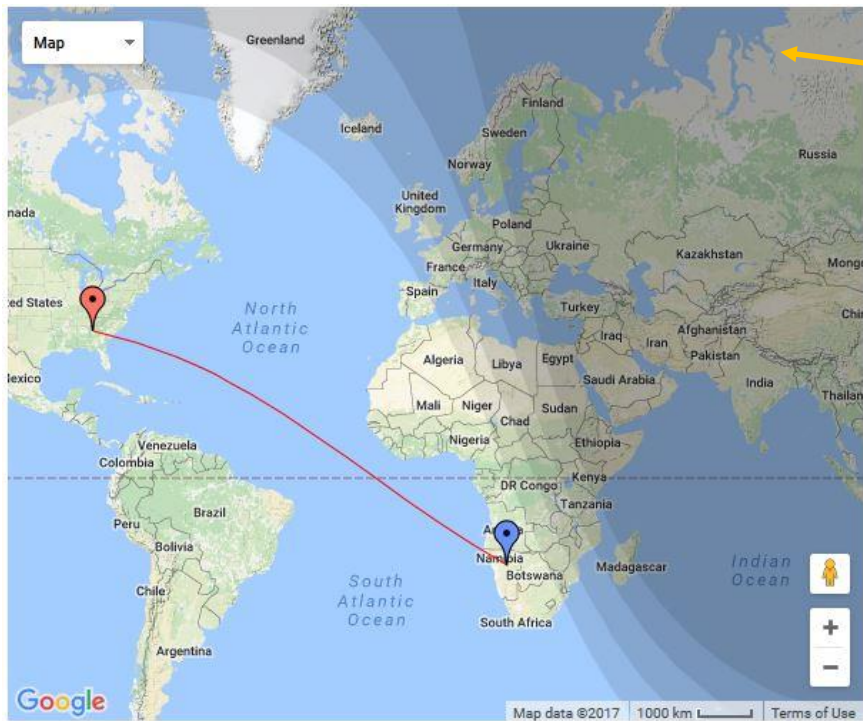
- Solar minimum does not mean completely zero propagation
- Great time to explore other parts of the spectrum, like VHF and UHF.
- Build new skills like working satellites (Future presentation maybe by Dan W4BBE)
- For HF, use the free resources available to us.
 - Spotter networks
 - Propagation prediction software
 - Test your antenna with analyzers and try WSPR net to understand how well it is working (Hint: we will learn this next meeting)

VOACAP — Voice of America Coverage Analysis Program

- VOACAP is the result of **50+ years** of U.S. HF research and development
- Considered by many as **the most professional HF system performance prediction tool** available on the market.
- Used currently for HF frequency planning by **Voice of America** and a number of other international HF broadcasters and institutions all over the world.
- Easy to use** graphical user interface and, for advanced users, powerful command line options
- Detailed Point-to-Point graphs and Area Coverage maps for **22 parameters** of circuit quality such as:
 - SNR (Signal-to-Noise Ratio)
 - Reliability of the path
 - Required Power Gain
 - Signal Power
 - MUF
 - Antenna Characteristics: Takeoff/Arrival Angle, and more



VOACAP DASHBOARD



World Map with path and gray line

Probability of propagation
Per band and time in UTC

When? You can set this for time
in the past. Why was I able to
talk with Africa?

To RX: 12368 km, 7685 mi, 102 ° Grayline: 2017-01-09 16 : 57 Set Reset

Propagation Params

Es: No Model: Auto

SSN: Min.TOA: 0.1 °

Today's Sunrise/Sunset Times (UTC)

	Transmitter		Receiver	
	Rise	Set	Rise	Set
GND	12:45	22:47	04:18	17:38
D	12:14	23:17	03:51	18:05
F	11:35	23:56	03:14	18:42

Transmitter Site

QTH: << Select a location >>

Name: EM74sa Loc calc

Latitude: 34.0210 [-90..90]

Longitude: -84.4580 [-180..180]

TX antenna: Dipole @ 10M (33ft)

TX power: 100 W

TX mode: CW

Specials: Swap TX-RX Short-path

Current point: Set Home Unset Home

Receiver Site

QTH: << Select a location >>

Name: JG89ra Loc calc

Latitude: -20.9614 [-90..90]

Longitude: 17.4688 [-180..180]

RX antenna: Dipole @ 10M (33ft)

Noise level: Quiet (153)

Run prediction

Information about the
Transmitter site

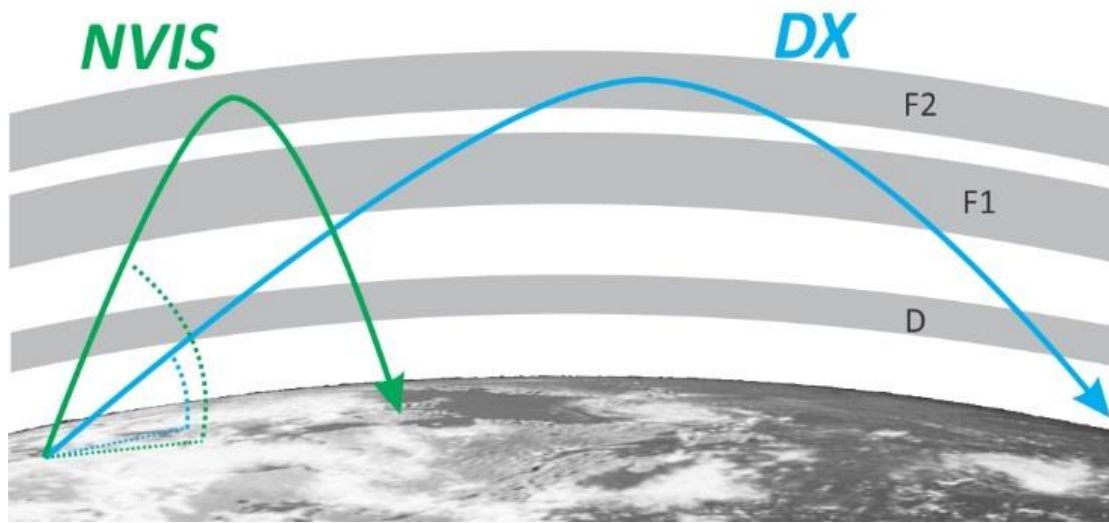
Information about the
Receiver site

Run button



www.voacap.com

How much does the antenna matter?



- It matters a lot!
- Proper height from ground and low SWR insure you get what you expect.
- Takeoff angle determines skip zones
- High angles = NVIS
 - Near Vertical Incident Sky wave

How well does prediction work?

List

Incoming 5

Awards

Leaderboard

Help

Add QSO

KB4MG Logbook

QSO's: 670

Confirmed: 117

Countries: 60

1

▶▶

of 45

Sort: Date - new->old

Find

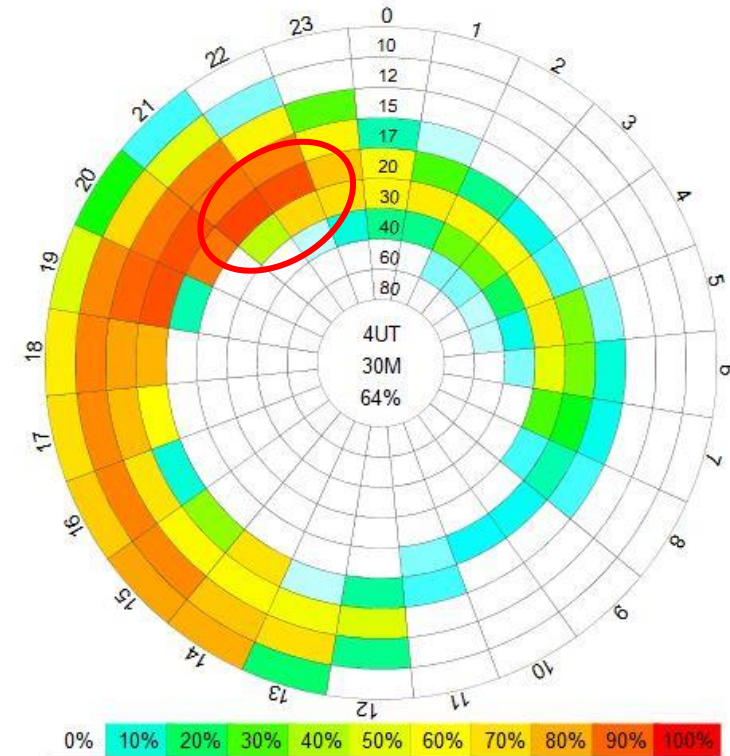
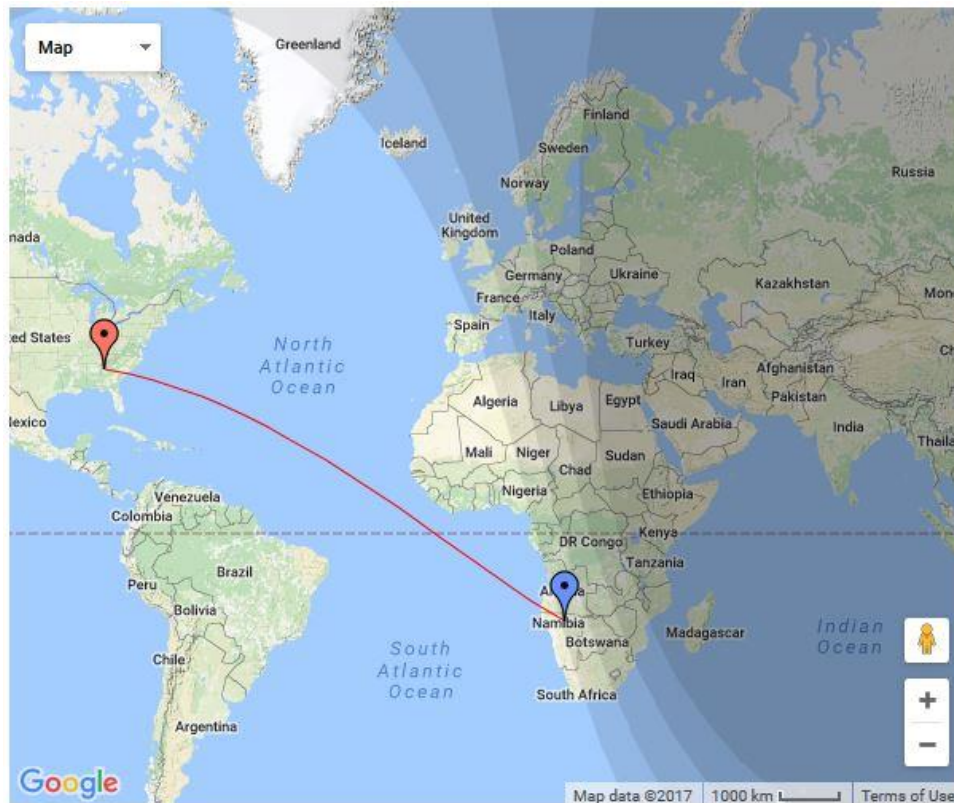
Viewing: All QSOs

	Date	Time	Call	Band	Freq	Mode	Grid	Country	Operator Name	Comments
1	2017-01-07	22:33	K9ZJ	20m	14.076	JT65A	EN53ua	 United States	Richard W Hageman Jr	
2	2017-01-03	00:05	LU2ICA	20m	14.076	JT65A	GG22ij	 Argentina	MARCELO OSCAR CALESPLANER	
3	2016-12-31	21:37	V51WW	20m	14.247	SSB	JH81OC44	 Namibia	Wynand A Wolmarans	
4	2016-12-31	21:12	K7ONP	20m	14.250	SSB	CN87mq	 United States	Oidar Hill Radio Club	NPOTA NP 44 Olympic National Park
5	2016-12-31	21:09	OF9X	20m	14.250	SSB	KP17uw	 Finland	Santa Claus World	Santa Claus World - Finland
6	2016-12-25	18:45	EA8AM	20m	14.266	SSB	IL18sk	 Canary Islands	LUCIANO DE LA ROSA GUTIERREZ	

My log from 12/31/16

Worked V51WW in Namibia on 20m at 2137 UTC

What did the predictions say about that?



To RX: 12230 km, 7599 mi, 100 ° Grayline: 2016-12-31 21 : 37 Set Reset

Propagation Params

Es: No Model: Auto

SSN: Min.TOA: 0.1 °

Today's Sunrise/Sunset Times (UTC)

	Transmitter		Receiver	
	Rise	Set	Rise	Set
GND	12:45	22:47	04:23	17:35
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Latitude: 34.0210 [-90..90]

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TX antenna: Dipole @ 10M (33ft)

TX power: 100 W

TX mode: CW

Specials: Swap TX-RX Short-path

Current point: Set Home Unset Home

Receiver Site

QTH: << Select a location >>

Name: JH81OC Loc calc

Latitude: -18.8960 [-90..90]

Longitude: 17.2090 [-180..180]

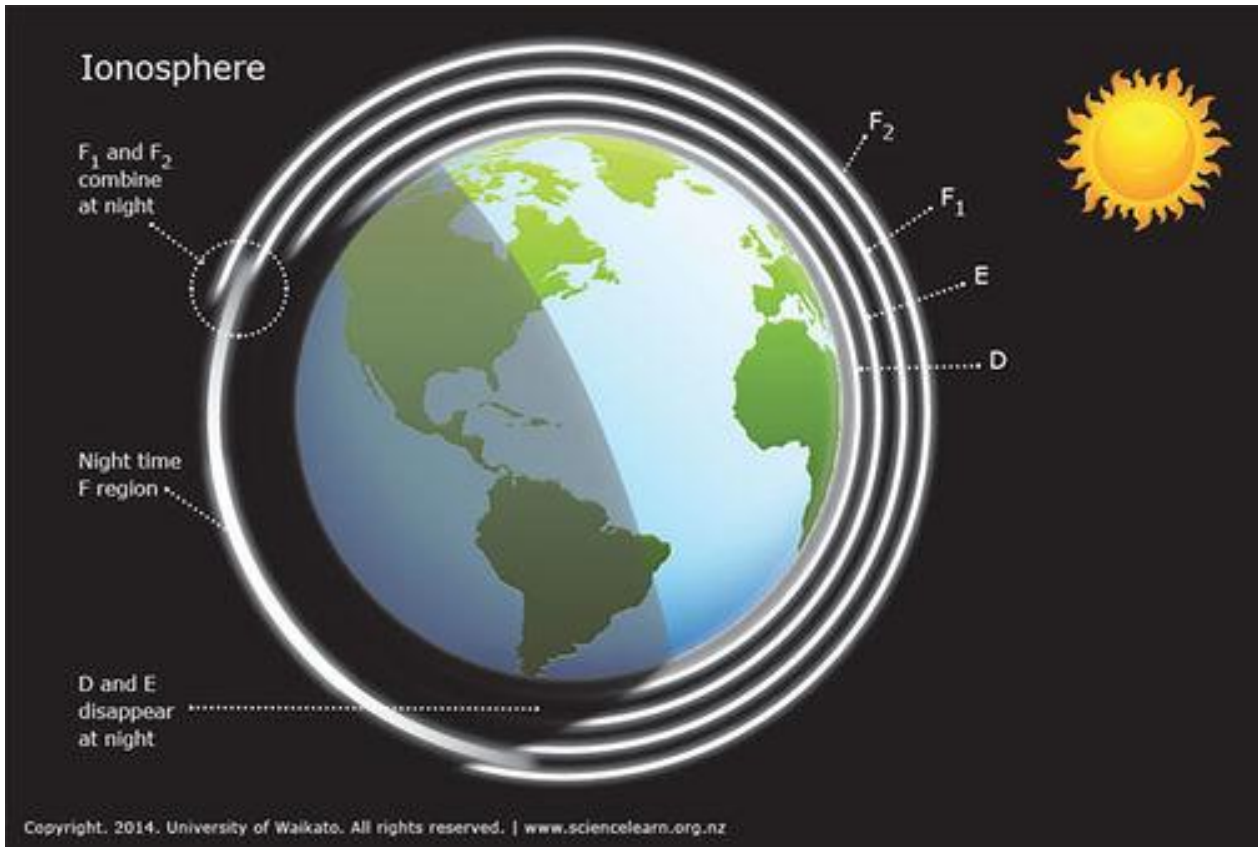
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Run prediction!

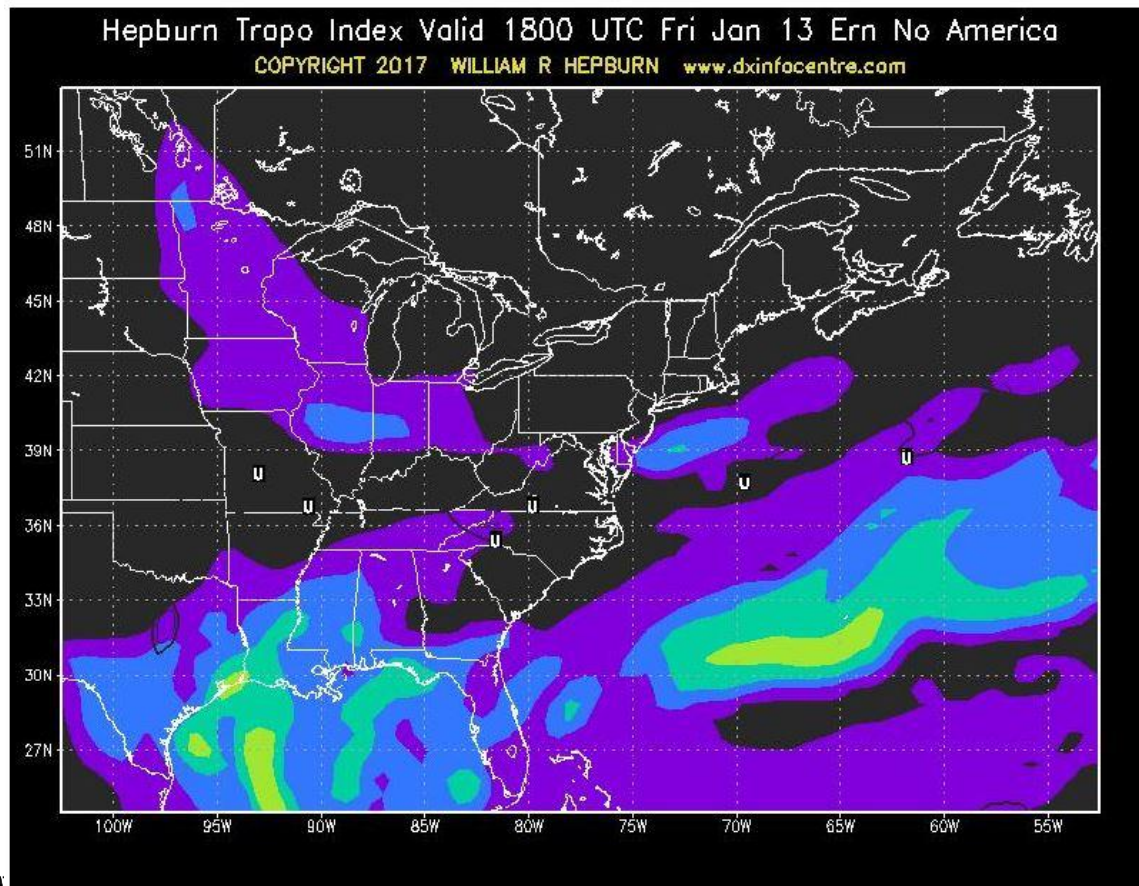
Extra advantage:
It happened at the
Gray line.
Why is that significant?

What is magic about the gray line?



- Layers don't all change at the same time.
- D layer disappears first allowing HF signals to better get to the other layers
- E dissipates shortly after D
- F1 and F2 remain for as much as a couple of additional hours
- DX is mostly off F1 and F2
 - If your skip distance aligns with the gray line, you get greatly improved propagation

VHF and UHF Propagation



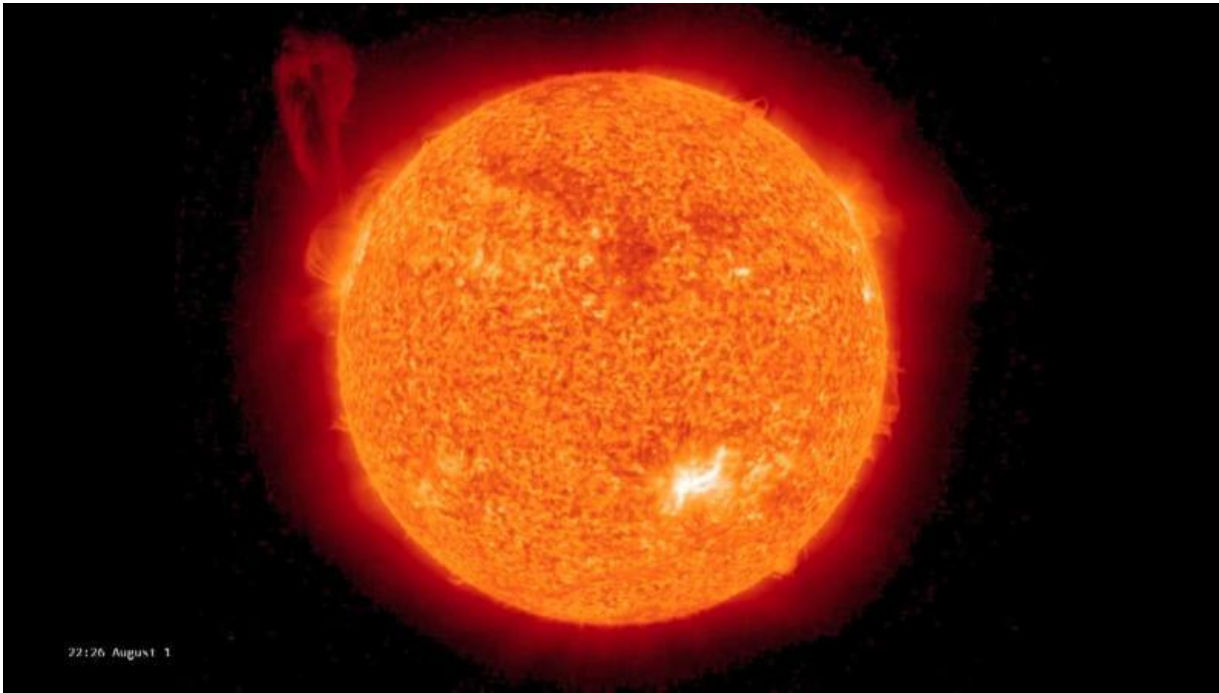
Signals normally can't go further than the visual horizon from the height of the antenna

At certain times the troposphere will “duct” VHF and UHF signals beyond the horizon.

You can get a daily forecast of the expected troposphere ducting.

<http://www.dxinfocentre.com/tropo.html>

Detrimental Sun Activity - Flares



August 1, 2010

[Video](#)

- Some activity can be detrimental to radio, satellites, GPS , our astronauts, and even our power grid, if strong enough. (EMP)
- Causes huge Aurora, or Northern lights
- Solar Flares are storms on the sun. If earth directed, they can cause damage.
 - C class = small flare
 - M class = medium flare
 - X class = large or huge flare
- NOAA site for space weather is
 - www.swpc.noaa.gov

New focus on space weather

Obama orders government to prepare for 'space-weather events'

By NICOLE DURAN (@DURANNI1) • 10/13/16 11:27 AM



Mail



Print



More

President Obama issued an executive order Thursday outlining how the federal government will prepare for and respond to "space-weather events," such as solar flares that can wreak global havoc.

These events "occur regularly, some with measurable effects on critical infrastructure systems and technologies, such as the Global Positioning System (GPS), satellite operations and communication, aviation and the electrical power grid," the order said. "Extreme space-weather events ... could disable large portions of the electrical power grid, resulting in

Other Space Weather sites for Hams

www.SOLARHAM.com

www.Hamqsl.com

<http://www.hfpropagation.com/>

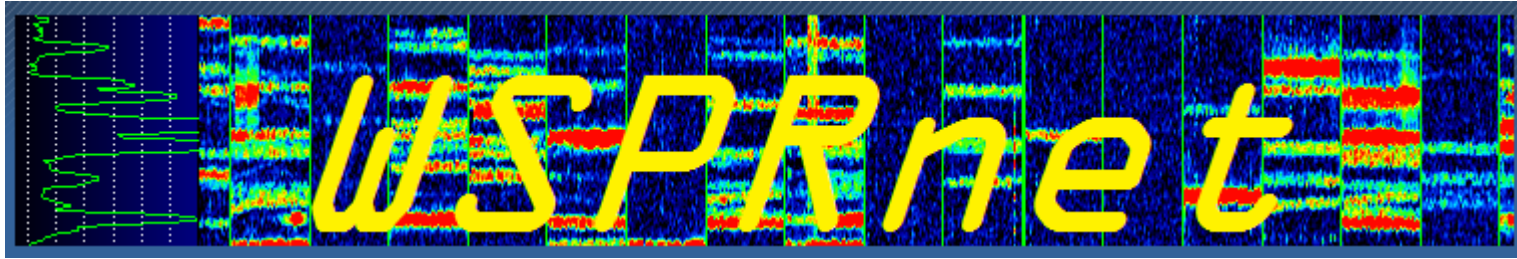
You can occasionally hear Dr Tamatha Skov give the solar forecast on the Ham Nation video podcast on Wednesday evenings.

Her website:

Spaceweatherwoman.com



Below the noise floor



- Matt Pesch had a setup at Field day and has presented on this topic previously
- Other modes like FT8 are similar technology
- Check WSFT-X site for more info. Dr Joe Taylor continues to develop these technomo