Basics of HF Operating

Bands, modes, propagation, on-air procedures, and using rig controls to get the most out of your HF transceiver



Mel Granick - KS2G Ham Radio University January 4, 2020

What Are The HF Bands?

Ten Frequency Ranges Between 1.8 and 30 MHz

160 Meters ... 1.8 to 2.0 MHz

- 80 Meters ... 3.5 to 4.0 MHz
- 60 Meters ... 5330.5 to 5403.5 kHz (5 Specific Channels)
- 40 Meters ... 7.0 to 7.3 MHz
- 30 Meters ... 10.1 to 10.150 MHz
- 20 Meters ... 14.0 to 14.350 MHz
- 17 Meters ... 18.068 to 18.168 MHz
- 15 Meters ... 21.0 to 21.450 MHz
- 12 Meters ... 24.890 to 24.900 MHz
- 10 Meters ... 28.0 to 29.7 MHz

Why So Many Bands?

Each HF band has particular <u>propagation</u> characteristics:

- Long-range vs. Short-range
- Daytime vs. Nighttime
- Summer vs. Winter
- Top vs. Bottom of Sunspot Cycle
- Also:
 - Noise Levels
 - Types of QSOs Found Most Often

"Lower" vs "Higher" Bands

Generally Speaking.

Lower Bands (160-40 Meters)

- Better in Winter than Summer
- Better at Bottom of Sunspot Cycle
- Local/Regional Daytime -- DX at Night
- Higher Bands (30-10 Meters)
 - Better in Summer Than Winter
 - Better at Top of Sunspot Cycle
 - DX Day and Night (at top of cycle)
 - DX Day Closed at Night (bottom of cycle)

HF Sub-Bands

Each HF Band is divided into frequency ranges for specific:

- Modes -- cw, digital/data, phone
- License Classes
 - Novice / Technician
 - General
 - Advanced
 - Extra

HF Sub-Bands by Mode

CW

- Permitted on any frequency on any band
- Generally found in lowest part of each band

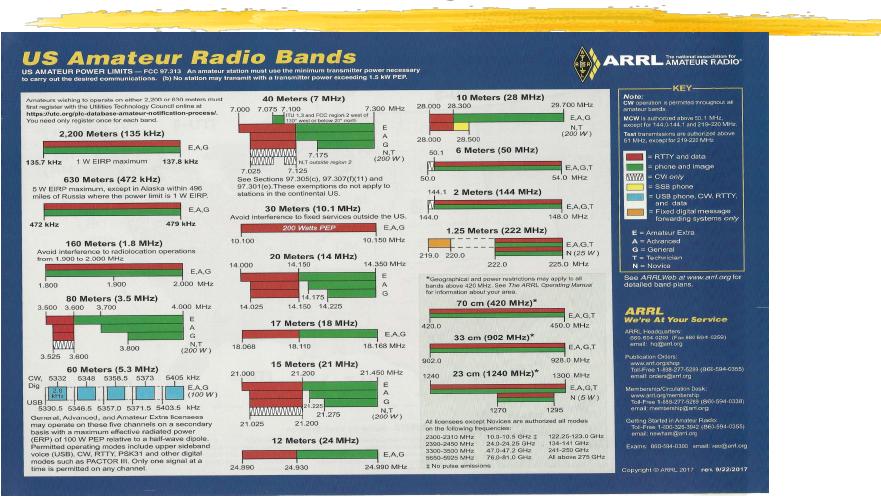
Digital/Data

- Permitted in lowest part of each band
- Generally found just above cw

Phone

- Permitted in the upper 1/2 to 3/4 of each band
 - LSB on 40 Meters and below
 - USB above 40 Meters

HF Sub-Bands by License



Be Aware of Band and Sub-Band Edges

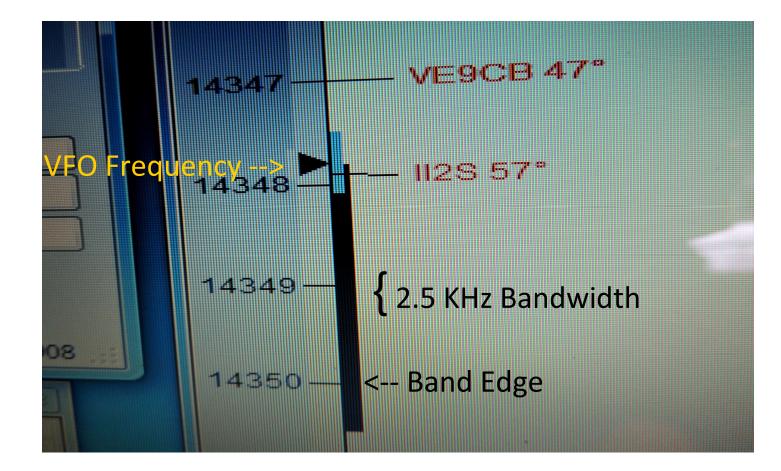
On SSB, Bandwidth typically is 2.5 - 3 KHz

- Therefore ... stay at least 3 KHz from the edge of band or sub-band
- On LSB ... 3 KHz **ABOVE** the bottom edge
- On USB ... 3 KHz **BELOW** the top edge

Examples:

- **Bottom** of 40-Meter General Phone Sub-Band is 7.175 MHz. Transmit **no lower** than 7.178 MHz.
- **Top** of 20-Meter Phone Band is 14.350 MHz. Transmit **no higher** than 14.347 Mhz.

Out of Band!



What Modes Where On Each Band

The Considerate Operator's Frequency Guide

The following frequencies are generally recognized for certain modes or activities (all frequencies are in MHz) during normal conditions. These are not regulations and occasionally a high level of activity, such as during a period of emergency response, DXpedition or contest, may result in stations operating outside these frequency ranges.

Nothing in the rules recognizes a net's, group's or any individual's special privilege to any specific frequency. Section 97.101(b) of the Rules states that "Each station licensee and each control operator must cooperate in selecting transmitting channels and in making the most effective use of the amateur service frequencies. No frequency will be assigned for the exclusive use of any station." No one "owns" a frequency.

It's good practice — and plain old common sense — for any operator, regardless of mode, to check to see if the frequency is in use prior to engaging operation. If you are there first, other operators should make an effort to protect you from interference to the extent possible, given that 100% interference-free operation is an unrealistic expectation in today's congested bands.

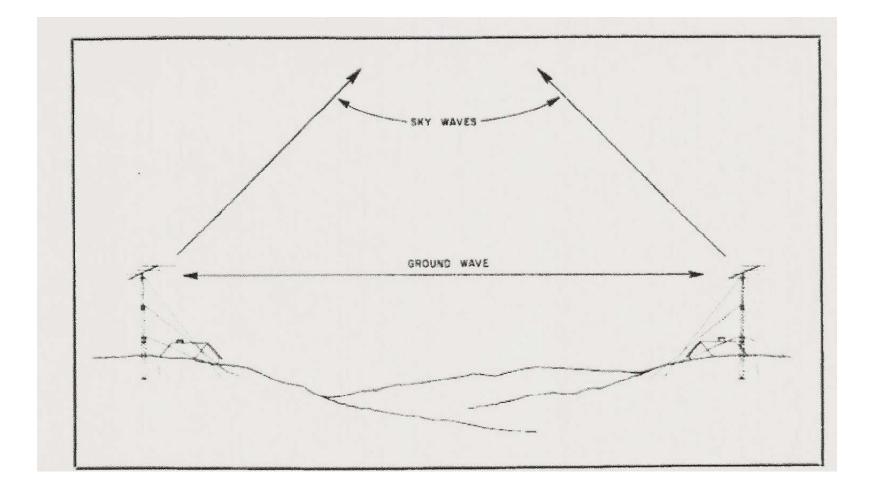
Frequencies	Modes/Activities	Frequencies	Modes/Activities	
1.800-2.000	CW	14.233	D-SSTV	
		14.236	Digital Voice	
1.800-1.810	Digital Modes	14.230	QRP SSB calling frequency	
1.810	CW QRP calling frequency			
1.843-2.000	SSB, SSTV and other wideband	14.286	AM calling frequency	
	modes			
1.910	SSB QRP	18.100-18.105	RTTY/Data	
1.995-2.000	Experimental	18.105-18.110	Automatically controlled data stations	
1,999-2.000	Beacons	18.110	IBP/NCDXF beacons	
1.000 2.000	Beddenie	18,162,5	Digital Voice	
3.500-3.510	CW DX window			
3.560	QRP CW calling frequency	21.060	QRP CW calling frequency	
		21.070-21.110	RTTY/Data	
3.570-3.600	RTTY/Data	21.090-21.100	Automatically controlled data stations	
3.585-3.600	Automatically controlled data stations		IBP/NCDXF beacons	
3.590	RTTY/Data DX	21.150		
3.790-3.800	DX window	21.340	SSTV	
3.845	SSTV	21.385	QRP SSB calling frequency	
3.885	AM calling frequency			
3.985	QRP SSB calling frequency	24.920-24.925	RTTY/Data	
0.000		24.925-24.930	Automatically controlled data stations	
7.030	QRP CW calling frequency	24,930	IBP/NCDXF beacons	
7.040	RTTY/Data DX			
7.070-7.125	RTTY/Data	28.060	QRP CW calling frequency	
		28.070-28.120	RTTY/Data	
7.100-7.105	Automatically controlled data stations	28.120-28.189	Automatically controlled data stations	
7.171	SSTV	28.120-28.189	Beacons	
7.173	D-SSTV			
7.285	QRP SSB calling frequency	28.200	IBP/NCDXF beacons	
7.290	AM calling frequency	28.385	QRP SSB calling frequency	
		28.680	SSTV	
10.130-10.140	RTTY/Data	29.000-29.200	AM	
10.140-10.150	Automatically controlled data stations	29.300-29.510	Satellite downlinks	
10.140-10.100	/ atomatically controllog data stations	29.520-29.580	Repeater inputs	
14.060	QRP CW calling frequency	29.600	FM simplex	
	RTTY/Data	29.620-29.680	Repeater outputs	
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14.095-14.0995	Automatically controlled data stations	ADDI hand plana	for frequencies above 28.300 MHz	
14.100	IBP/NCDXF beacons	are shown in The ARRL Repeater Directory and on		
14.1005-14.112	Automatically controlled data stations			
14.230	SSTV	www.arrl.org.		

Digital Mode "Watering Holes"

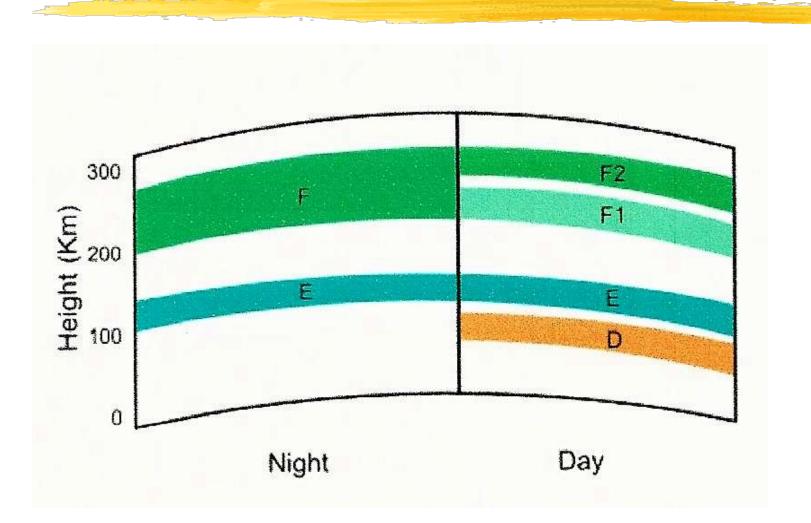
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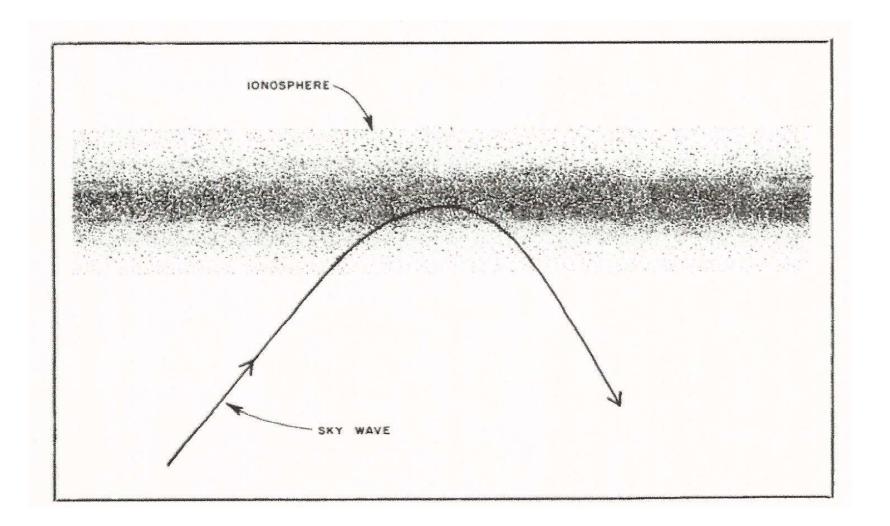
HF Propagation: Ground Wave / Sky Waves



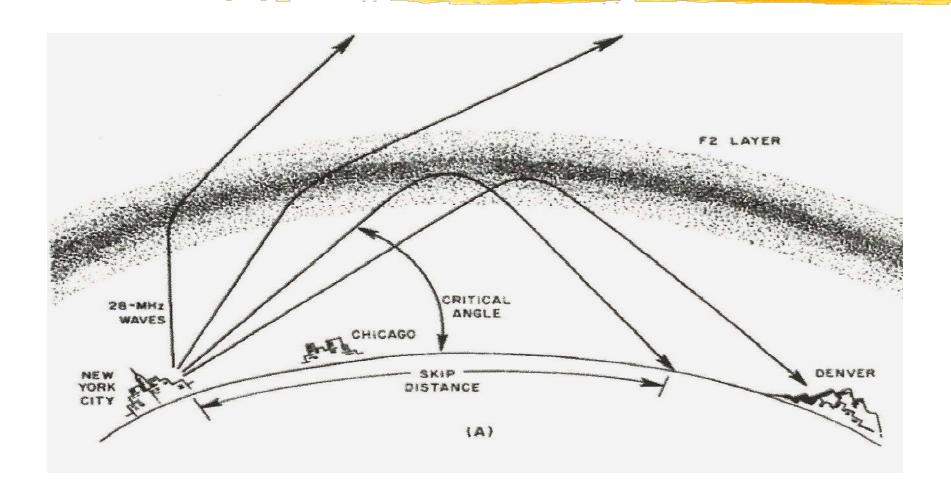
HF Propagation: The lonosphere Layers



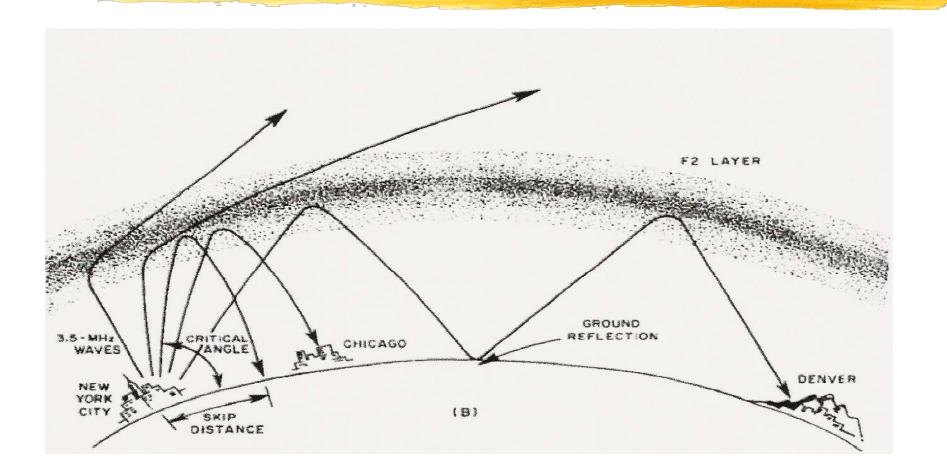
The lonosphere Can *Refract* Sky Waves



Sky Wave Refraction: Long-Distance "Skip"



Multi-Hop Propagation



Which Bands When?

Lower Frequency Bands

160, 80, 60, 40 Meters
Ground Wave Daytime (Local / Regional)
Sky Wave Nighttime (DX)

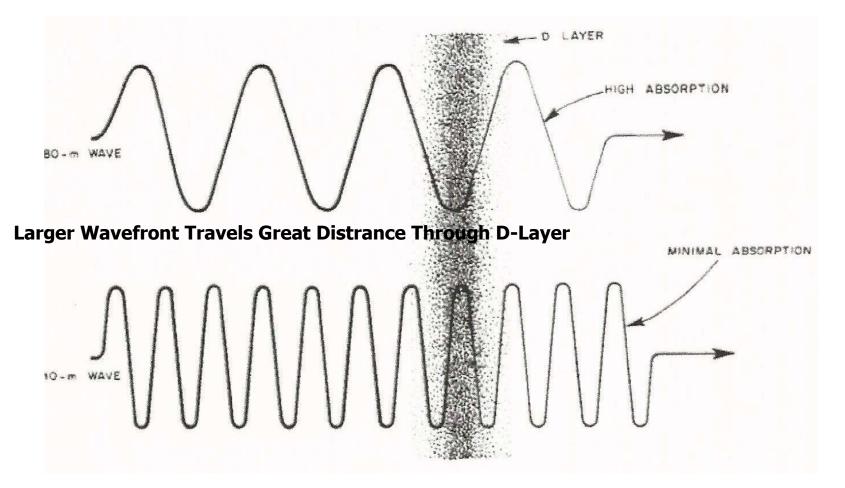
Upper Frequency Bands

30, 20, 17, 15, 10 Meters
Both Ground Wave & Sky Wave

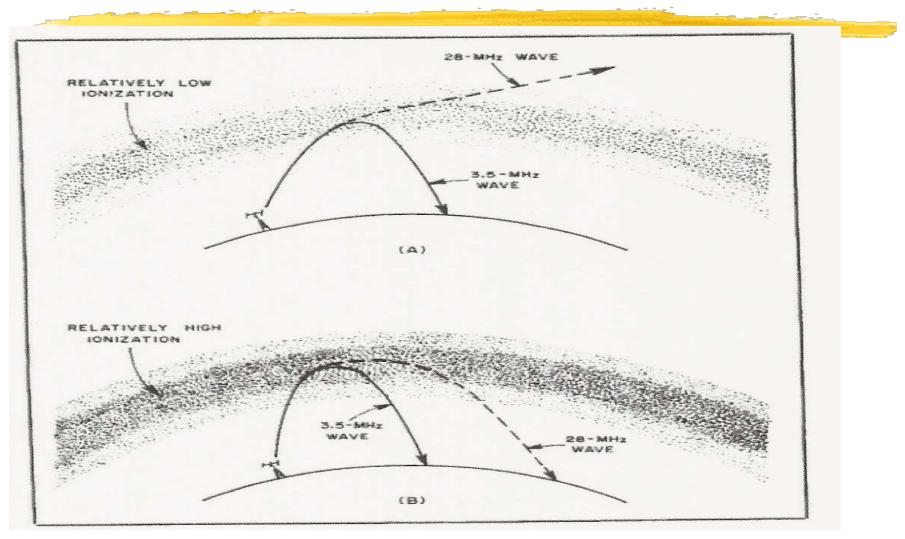
Day and Night (When Open)

D-Layer Absorption

Lower Frequency = Higher Absorption



Frequency and Ionization Level



Sky Wave & Sunspots

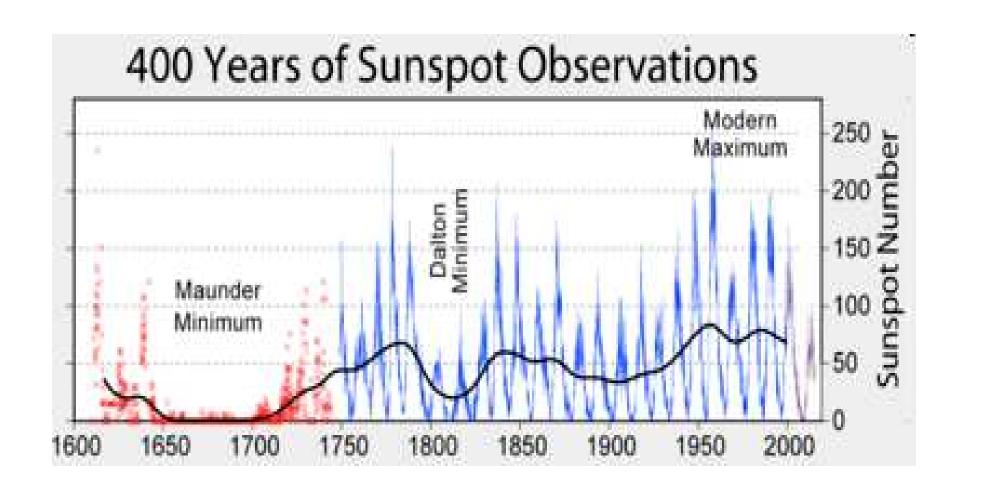
Ionization Determined by Sunspot Activity

- More Sunspots = More Ionization
- More Ionization = More DX at Higher Frequencies

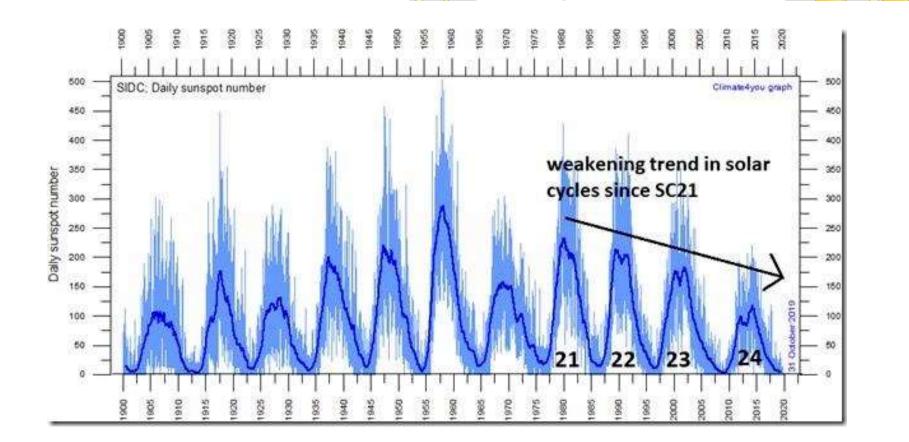
Sunspots Rise and Fall in 11-Year Cycles

Discovered in 1843 by Samuel Heinrich Schwabe, who retrospectively started a numbering scheme with 1755-1766 as Cycle #1

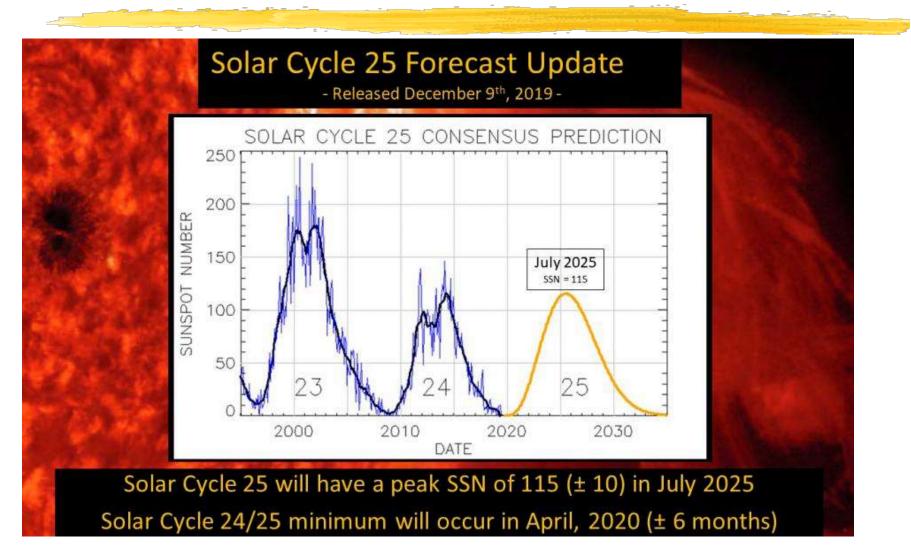
Modern Sunspot Maximum Was 1959 - Peak of Cycle 19



Strengths of Cycles Have Been Declining

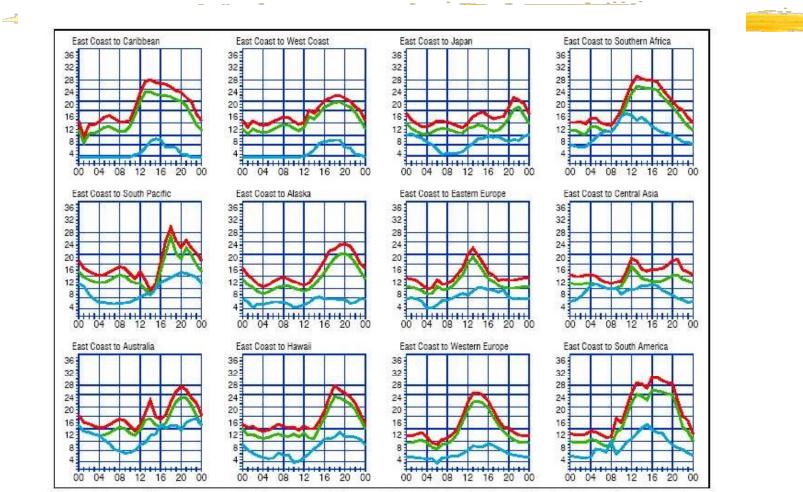


Currently, We Are Approaching The End (Bottom) of Cycle 24



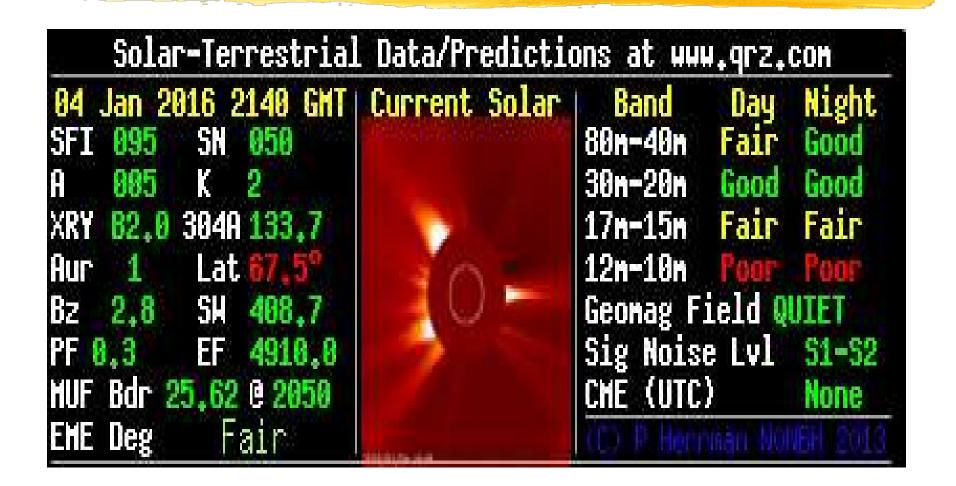
How Do I Know Which Band To Use?

http://www.arrl.org/qst/propcharts/

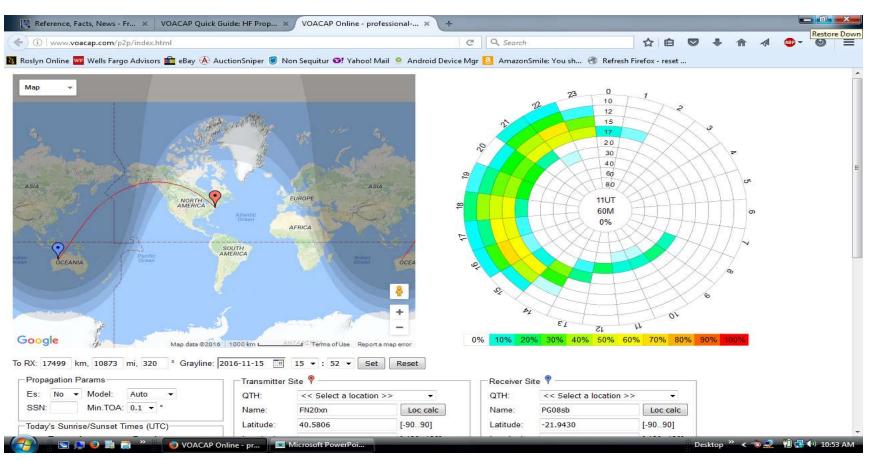


When are the bands open? These charts, generated using CAPman, show probabilities for average HF propagation in the month of January 2007 for the paths indicated. The horizontal axes show Coordinated Universal Time (UTC), and the vertical axes frequency in MHz. On 10% of the days of this period, the highest frequencies propagated will be at least as high as the upper red curves (HFF, highest possible frequency) and on 50% of the days they will be at least as high as the green curves (MUF, classical maximum usable frequency). The blue curves show the lowest usable frequency (LUF) for a 1500-W CW transmitter, For SSB or a lower transmitter power, the LUF will be somewhat higher than the blue curves indicate. See Oct 1994 QS7, pp 27-30, and Feb 1995 QS7, pp 34-36, for more details. The predictions assume an observed 2800-MHz solar flux value of 73. This is a Very Low level of solar activity. See the detailed propagation tables on 'The ARRL Antenna Book' CD-ROM'.

Solar Conditions Vary Day-to-Day ... Even Hour-to-Hour

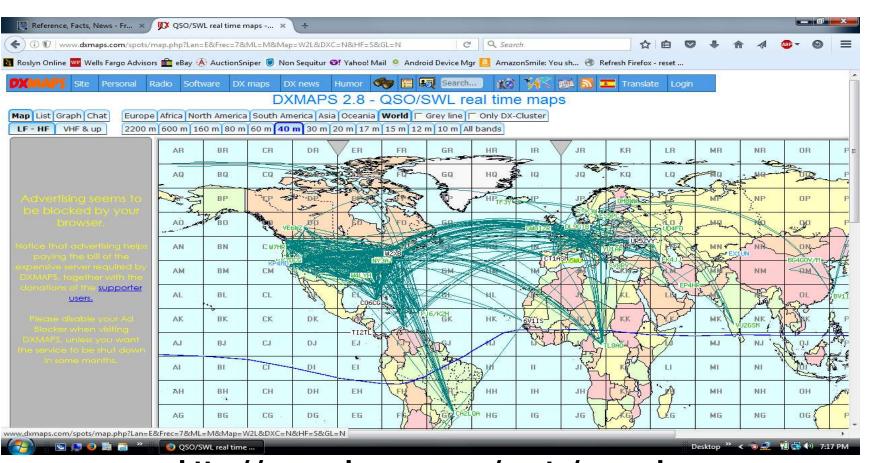


Propagation Calculators



http://www.voacap.com

Real-Time Path Views



http://www.dxmaps.com/spots/map.php

Making Contacts

Proactively:

- Call CQ
 - I Tune The Band
 - Get a "feel" for conditions and activity
 - **LISTEN** for a clear frequency
 - **ASK** "Is the Frequency in use?"
 - QRL? On CW
 - Because of how HF propagation works you often hear only one side of a QSO. So what appears to be a clear frequency may be occupied by a QSO in which you're not hearing one (or more) of the stations involved

Typical CQ Format

On Phone:

CQ, CQ, CQ calling CQ 20 meters. This is KS2G calling. Kilo Sierra Two Golf, KS2G near New York City calling CQ 20 meters. Hello CQ, CQ, CQ calling CQ 20 meters and standing by for a call.

On CW / RTTY:

CQ CQ DE KS2G KS2G CQ CQ DE KS2G KS2G K

Making Contacts

Respond to CQ's

- Casual" Contacts
 - Phone: W2HF This is KS2G OVER
 - CW/RTTY: W2HF DE KS2G K
- DX Pile-Ups & DXpeditions
 - I Just Give Your Callsign
 - Phonetically on Phone
 - Is the DX Station Operating "Split?"
 - Almost All Dxpeditions Operate Split

Operating "Split"

Split-Frequency Operation

- Transmit and Receive on Different Frequencies
- Like the "offset" of repeater input/output

Almost All DXpeditions Operate "Split"

- DX Station Will Say "Up 5" or "Up 5 to 10"
 - He's listening 5 or 5-to-10 KHz up from his transmit frequency
- DX Station on 14.160 MHz Will Say "200 to 225"
 - He's listening 14.200 to 14.225 MHz
- Learn how to use your rig's dual VFO's

Working Contests

Competitive Operating:

- Work as many stations as possible, in as many places as possible, as quickly as possible
- Check Contest Rules For Contest "Exchange"
- "Run" -- call CQ
- Search & Pounce" -- Tune the Band and Respond to Stations That Call CQ

Logging

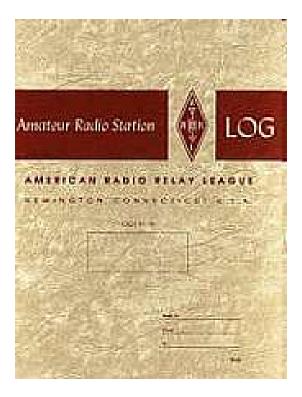
 No Legal Requirement To Log (since 1983)
 Useful Record of Operating Activity and Information Required For QLS'ing**

Date & Time in UTC**

- Frequency Band/Mode (cw, ssb, rtty, etc.)**
- Callsign of Station Worked**
- Signal Report
- Notes -- Name, QTH, Equipment, Powr, etc.

Logging - "Old School"

On Paper:





Computer Logging

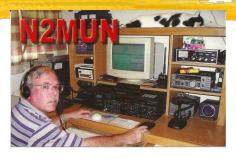
General Purpose Loggers:

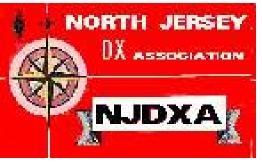
- DXLAB RumLog (Mac)
- DX 4 WIN MacLoggerDx (Mac)
- DXKeeper TWlog (Linux)
- Specialized Contest Loggers:
 - N1MM-Plus Skookumlogger (Mac)
 - WriteLog Xlog (Linux)

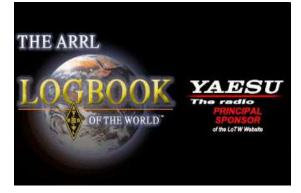
QSLing: Confirmation of Contacts

- Direct Printed Cards
 - SASE or "Green Stamps"
- QSL Managers
- QSL Bureaus
 - ARRL Outgoing QSL Service
 - 2nd District Incoming QSL Bureau
 - North Jersey DX Association
 - Purchase Return-Envelope "Credits"
- Electronic
 - ARRL Logbook of the World (LoTW)
 - eQSL
 - Club Log

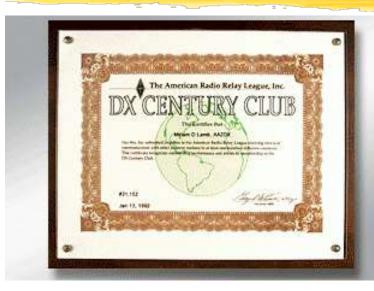




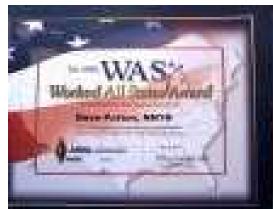




Operating Awards









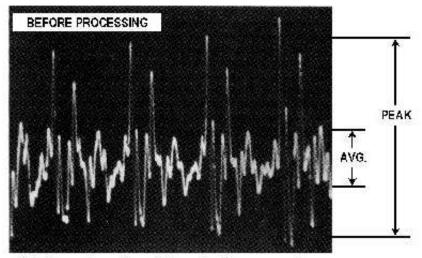
Getting The Most Out Of Your HF Transceiver

Transmitter Controls:

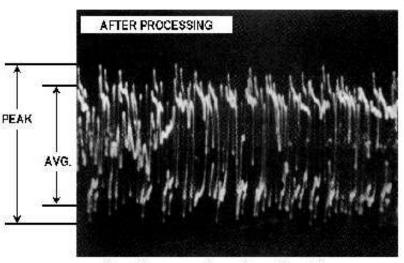
- RF Power Output cw, digital, ssb
- Microphone Level
 - Speech Processing / Compression
 - Increases Average RF Power & Adds "Punch" To Audio
 - Observe ALC (Automatic Level Control) Limit
 - Transmit Audio Equalization
 - Control "Highs" & "Lows" For Maximum Intelligibility
 - Transmit Audio Monitor
 - Listen To Yourself As You Transmit
 - Ask For Audio Reports From Stations You Work

Speech Processing

Also Known As Audio Compression Increases SSB "Talk Power"



Actual speech waveform pholograph with no processing, as it exists at the TX mike input. Note the very high peak amplitude when compared to the average levels.



Correctly processed speech waveform. The average amplitude *relative to the peaks* is now much higher. This is a dramatic increase in the average power output, but without the risk of distortion because the peaks have been limited by diode clipping.

Transmitter Keying Controls

VOX (Voice Operated Transmit)

- Transmitter is Keyed By Sensing Speech
 - Sensitivity / Delay (Hang) Time / Anti-VOX
- CW Break-In
 - Automatic Switching Between Transmit & Receive
 - Full Break-In (QSK)
 - Switches from transmit to receive immediately when key contacts open
 - Semi-Break-In
 - When key contacts open, switch to receive is delayed by a set duration (usually controlled by VOX setting)

Automatic Antenna Tuner

- Automatically "matches" out-of-resonance antenna impedance to 50 ohms
- Maintains Full Transmitter Power Output
 - Modern Solid-State Transmitters "Fold-Back" (Lower) Output Power to Mismatched Antenna Loads To Prevent Damage To Final Output Power Transistors

Receiver Audio Controls

AF Gain

- Audio Frequency Gain Volume Control
- RF Gain
 - Radio Frequency Gain
 - Manually Adjusts Receiver Sensitivity
 - Usually Left at Maximum in Conjunction With AGC
- AGC Automatic Gain Control
 - Automatically Adjusts Receiver Sensitivity In Response To Changes In Signal Strength
 - Fast" Response For CW / "Slow" Response For SSB

Receiver Sensitivity Controls

RF Attenuator

Reduces Receiver Sensitivity By A Set Amount

RF Preamp

Increases Receiver Sensitivity By A Set Amount

Squelch

- Mutes Receiver When No Signal Is Present
- Leave "Wide Open" Except For FM

Receiver Tuning Controls

RIT

- Receiver Incremental Tuning
- Clarifier" on Yaesu Radios
 - Changes Receive Frequency Without Changing Transmit Frequency

XIT

- Transmitter Incremental Tuning
 - Changes Transmit Frequency Without Changing Receive Frequency
 - Sometimes can be used for "split" in the absence of dual VFO's

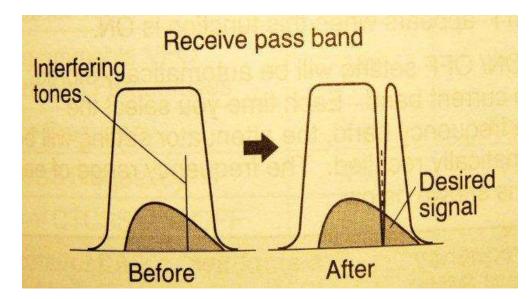
Interference Controls

Noise Filter / Noise Reduction

- Reduces Steady Background Noise
- Noise Blanker
 - Reduces Pulsing Background Noise

Notch Filter

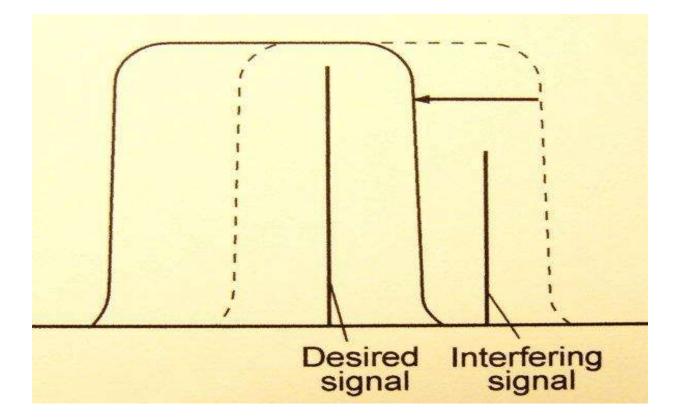
"Nulls" Specific
 Interfering Signal
 (e.g. Heterodynes)



Bandwidth Controls

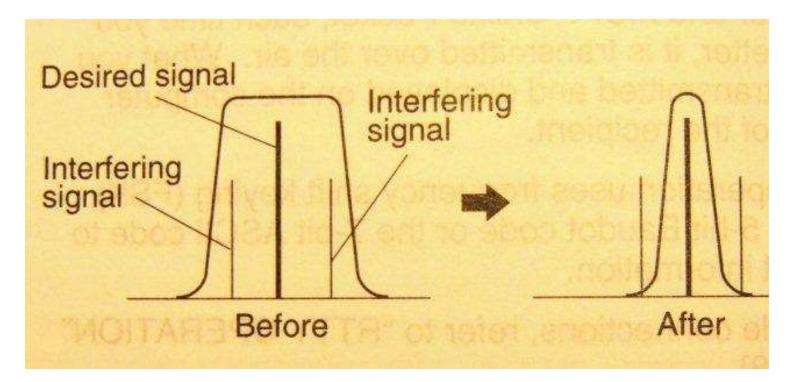
IF Shift

Shifts Center Frequency of Pass Band



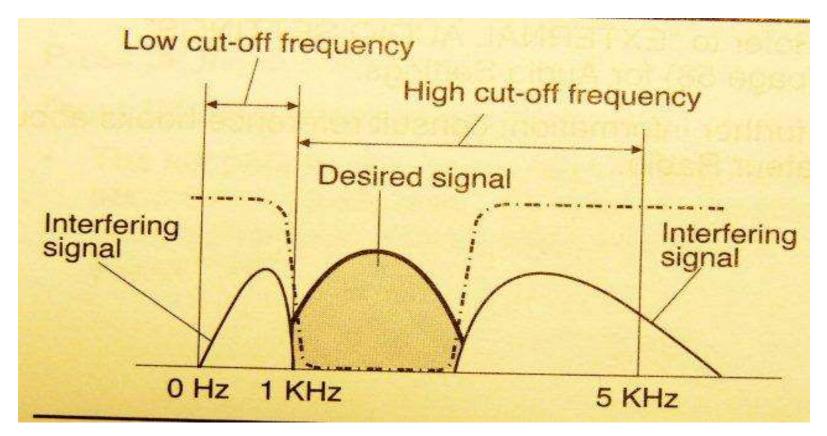
Bandwidth Controls

Wide / Narrow (DSP & Roofing) FiltersFixed Bandwidth (CW & FSK)



Bandwidth Controls

Variable Bandwidth Filters



Quick Review:

Propagation Characteristics

Be aware of band edges

Check daily solar conditions

DX Summit site

In a SSB contest just send your call - The DX station will send back your call and then the contest exchange

Radio Review:

Getting the most out of your HF transceiver

- Speech processing (Punch)
- Audio Equalization
- Interference control
- Noise filter/noise reduction
- Bandwidth IF Shift
- Pull that weak signal out of the mud
- Reduce RF gain increase AF gain

Final Words:

Learn how to use Split

- Good videos on YouTube
- Working a contest
 - Before contest check rules
 - WA7BNM contest resource, ARRL, CQ
 - Plan your strategy
 - Class, time allocation, GOAL!
- Antenna Tuner vs Antenna characteristics

73, CU On The Air!



Any questions?