Propagation 101

The Basics of HF Propagation

WVARA

May 21, 2008, San Jose

By R. Dean Straw, N6BV

Senior Assistant Technical Editor (retired)

Albert Einstein — Explaining How Radio Works.

"You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles."

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"You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles."

"Do you understand this?"

"And radio operates exactly the same way: you send signals here, they receive them there."

Albert Einstein — Explaining How Radio Works

"The only difference is that there is no cat."



So How Does a Radio Wave Propagate?

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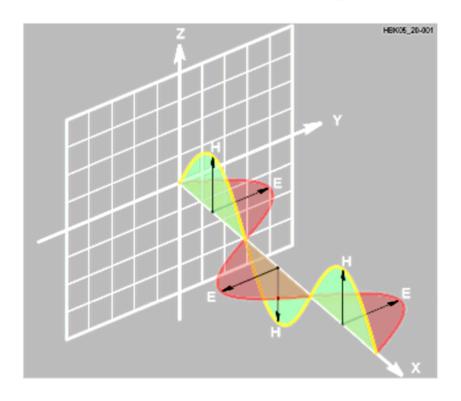
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So How Does a Radio Wave Propagate?

- My usual answer: "It's magic!"
- However, sometimes I'll say: "If you wiggle an electron it will produce an electromagnetic field."
- But all in all, I prefer Einstein's cat!



Radio-Wave Propagation



Electric and magnetic field components of an electromagnetic wave. (This is such a cool picture, from *The ARRL Handbook*, 2007 Ed.)

Radio-Wave Propagation

"The Earth is spherical and the waves do not penetrate its surface appreciably, so communication beyond visual distances must be by some means that will bend the waves around the curvature of the Earth."

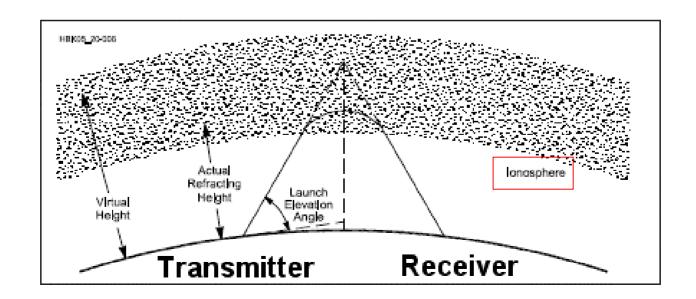


(From *The ARRL Antenna Book*, 21st Ed.)

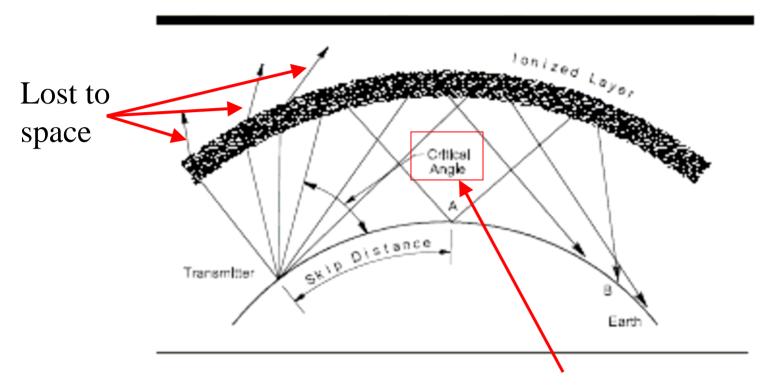
Radio-Wave Propagation

What we need is a "mirror" above the Earth to bounce signals all around the world.

Luckily, we have one. It's called the *ionosphere*.



Bending Around the Earth's Curvature



Behavior of waves encountering a simple curved *ionospheric layer* over a curved Earth. Waves higher than the *Critical Angle* are lost to space. Lower-angle waves are bent and redirected back down to Earth. (From *The ARRL Antenna Book*, 21st Ed.)

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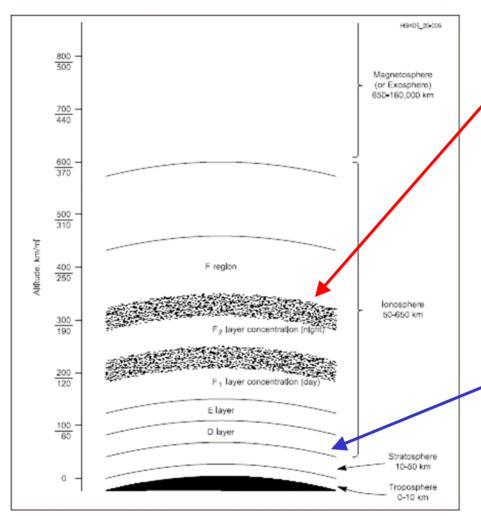
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 - X-rays.



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- These *free electrons* affect radio waves passing through the ionospheric regions.

Regions in the Atmosphere

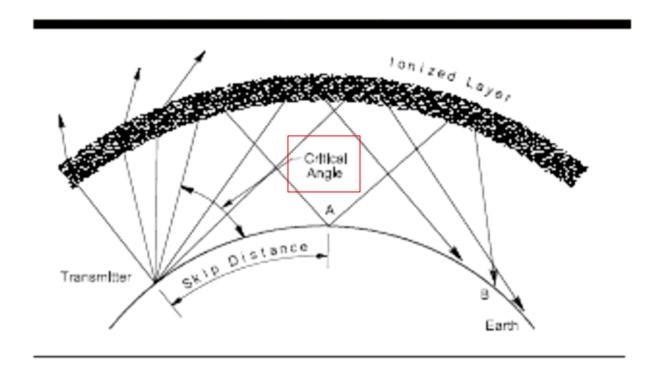


The F₂ region is responsible for most of the long-distance propagation at HF because it's the highest region above Earth.

The D region is the "bad guy," absorbing low-frequency waves

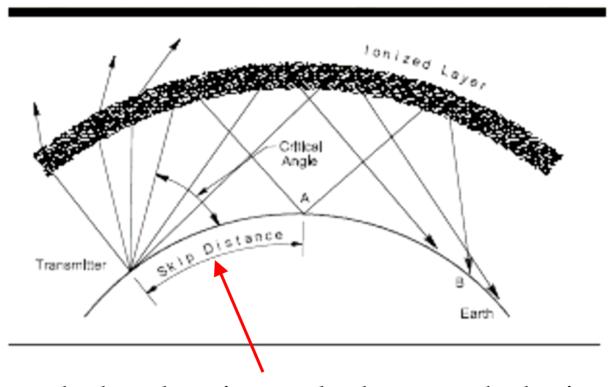
(From *The ARRL Handbook*, 2007 Ed.)

Critical Angle



The critical angle varies, depending on the frequency in use and on the level of ionization in the ionosphere. (From *The ARRL Antenna Book*, 21st Ed.)

What About Skip Distance (Zone)?



Waves launched at elevation angles between the horizon and the critical angle don't hit the Earth for some distance, after bouncing off the ionosphere. (From *The ARRL Antenna Book*, 21st Ed.) More about this skip zone later.

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Influences on Propagation Coverage

- Frequency, and month/day/hour.
- The state of the ionosphere.
- Antenna gain and transmitter power.
- The launch elevation angle.
- Noise level at receiver (signal-to-noise ratio).

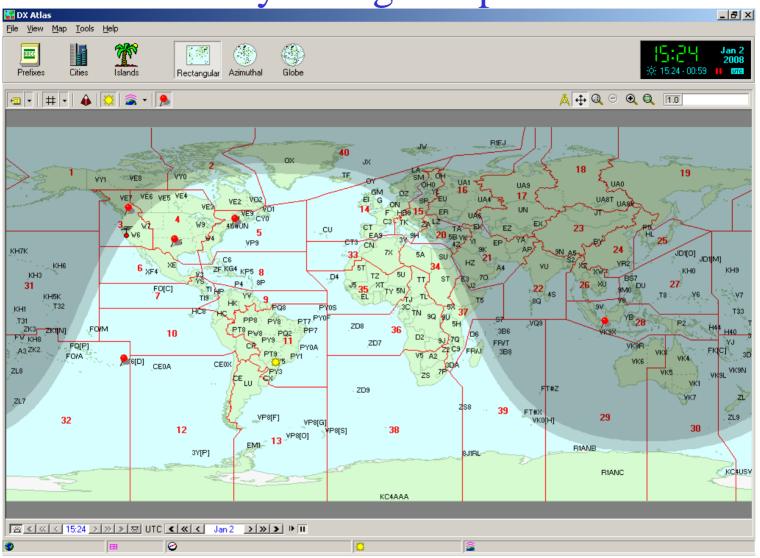
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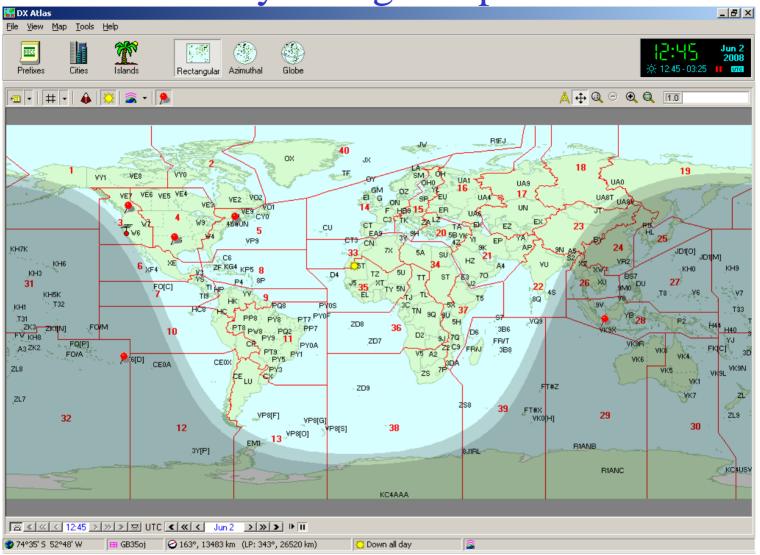
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 - Transition day-to-night depends on month

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Sunrise, W6 in January

Transition day-to-night depends on month



Sunrise, W6 in June

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- The state of the ionosphere.
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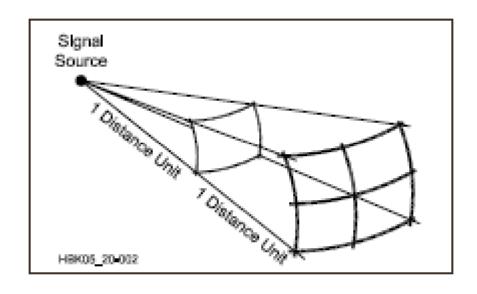
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 - Effected by solar Coronal Mass Ejections (CMEs)

Influences on Propagation Coverage

- Frequency and month/day/hour.
- The state of the ionosphere.
- Antenna gain and transmitter power.
- The launch elevation angle.
- Noise and QRM level at distant receiver (signal-to-noise ratio).

Spreading Out the Energy — the Signal Gets Weaker



Radio energy density "spreads out" as the square of the distance from its source. Therefore, signals get weaker as they depart from your antenna — This is called *spreading loss*. (From *The ARRL Handbook*, 2007 Ed.)

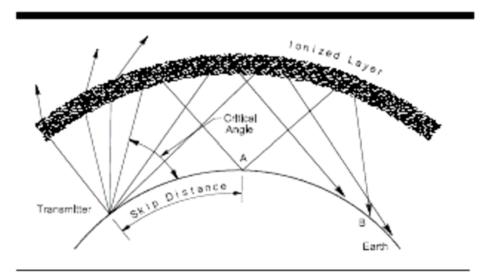
Antenna Gain?

"It is important to remember this so-called *spreading loss* when antenna performance is being considered. Gain can come only from narrowing the radiation pattern of an antenna, which concentrates the radiated energy in the desired direction."

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 - Generally speaking, the lower the launch angle from your antenna, the fewer the number of lossy hops necessary to travel to a distant receiver.



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 - Generally speaking, the lower the launch angle from your antenna, the fewer the number of lossy hops necessary to travel to a distant receiver.
 - Conversely, to get to a nearby receiver using NVIS techniques, requires low horizontal antennas "warming the clouds."

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 - If there is local noise (QRN) or strong interference (QRM) at a distant receiver, your signal can't be heard.
 - For example, from California you may not be able to work a station in Thailand, because stations in Japan or Europe may be much louder than you are. The following prediction tables come from *The ARRL Antenna Book*.



W6 Evening Opening to Thailand

20 Meters: Dec., Thailand (Bangkok), for SSN = Low, Sigs in S-Units. By N6BV, ARRL.

		Zone ,00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23																						
	0.0	01	0.2	0.3	04	0.5	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KL7 = 01	9+	9+	9	9	8	5	-	-	-	-	-	-	-	1	2	1	-	-	-	-	5	-	-	5
VO2 = 02	2	4	2	1	1	-	-	-	-	-	-	4	9	9+	8	8	7	1	4	7	6	3	_	2
W6 = 03	9	8	8	2	-	-	-	-	-	-	-	-	1	-	-	-	1	5	7	6	1	-	-	7
W9 = 04	9+	8	2	-	-	-	-	-	-	-1	3	- 1	3	- 5	8	8	-2	-	- 1	3	3	-	-	6
W3 = 0.5	8	7	5	3	-	-	-	2	1	1	-	-	8	9+	8	6	1	-	-	2	5	-	-	4
XE1 = 06	9	8	3	-	-	-	-	2	4	6	7	6	4	5	8	6	1	1	-	-	-	-	-	3
TI = 07	9+	9	7	5	-	-	-	5	8	9	8	8	9	9	6	3	-	-	-	-	1	-	-	-
VP2 = 08	5	2	-	-	-	_	-	-	1	-	8	9	9	8	8	2	-	1	1	3	7	3	_	1
P4 = 09	8	6	1	_	_	_	1	1	4	2	7	9	9	8	7	1	_	_	1	2	6	3	_	1*
HC = 10	9+	7	7	5	1	1	1	5	5	6	7	9	9+	9	5	1*	-	-	_	_	2	_	_	2
PY1 = 11	9	9+	9	9	ī	-	_	_	ī	2	9	7*	2*	_	-	-	1	5	8	9	9+	9+	9	8
CE = 12	9	8	7	2 *	_	_	_	_	2	9	8	8	5	5	_	_	ī	-	ī	7	7	8	7	9
LU = 13	9+	a	8	- 6	1	_	_	_	1	2	ā	5*	5*	-	_	1	1	1	- 5	8	7	o o	á	ā
G = 14	1	-					6	8	9	9	9+	9+	9+	9+	9+	9+	8	1	-			-	1	1
I = 15	4	4	-		2	8	8	7	7	7	9	9	9+	9+	9+	9+	9	8	4	2	2	8	4	1
UA3 = 16	2	-	-	8	8	9	9	9	9+	9+	9+	9+	9+	9 +	8	1	-	۰	2	-	5	1	*	_
UN = 17	_		-	9+		-	-							_		- 5			_		-	1		
UA9 = 18	-	9+	9+		9+ 9+	9	9	9	9+	9+	9+	9+	9+ 9	9+ 4	8	5	8	,	5	6	1	-	-	-
	5	3	9+	9+		9	-	9+	9+	9+	4	7	_	4	-	-	-	-	-	-	1	-	-	-
UA0 = 19	9+	9+	9+	9	9	9	9	9+	9+	5	6	9	5	-	-	-	_	_	-	-	-	-	-	-
4X = 20	-	-	-	7	9+	9	9	6	6	8	9	9+	9+	9+	9+	9	7	7	3	-	-	-	2	1
HZ = 21	-	-	9+	9+	9	9	8	8	8	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9	8	9	8	1
VU = 22	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8
JT = 23	7	9+	9+	9+	9+	9	9	9+	9+	9+	9+	9+	9	4	9	8	7	4	4	7	5	-	-	-
VS6 = 24	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	9	5	-	-	4
JA1 = 25	9+	9+	9+	9	9	9	9	9+	9+	9+	9+	5	9	9	3	-	-	-	-	-	-	-	-	8
HS = 26	2	2	5	5	2	1	1	2	3	5	5	3	5	3	2	2	2	3	3	3	3	3	3	2
DU = 27	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9 +	9+	9+	9+	9+	9+	9+	9+	9+	9+	7	-	1	9+
YB = 28	4	9	9+	9+	9+	9+	9+	9+	9	9+	9 +	9+	9+	9+	9+	9+	8	9+	9+	9+	9+	9+	9	9+
VK6 = 29	9+	9+	9+	8	7	3	7	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8	8	9+
VK3 = 30	9	8	7	6	4	4	5	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9	9	9	8	6	6	9
KH6 = 31	5	4	4	5	5	6	8	9	9	9	9	9	9	9	8	5	-	-	9	8	1	-	3	7
KH8 = 32	2	1	2	1	2	4	7	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	8	2	1	5	4
CN = 33	5	9	7	1	_	_	8	6	6	9	7	7	8	9	9+	9+	9+	9+	9+	9+	9+	8	5	2
SU = 34	_	-	_	2	9+	9	8	6	7	8	8	9	9+	9+	9+	9+	9	9	7	5	2	2	3	2
6W = 35	8	9+	9+	7		-	_	5	3	9	4 *	3	4	5	8	9	9	9+	9+	9+	9+	9+	8	8
D2 = 36	5	9+	9	4	9	6	4	3	4	4	4	5	8	9	9	9+	9+	9+	9+	9+	9+	9+	ā	7
5Z = 37	1	4	6	9	8	7	5	4	4	4	5	8	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	6	í
ZS6 = 38	9+	9	9	9	8	7	5	3	4	4	5	7	9	9	9+	9+	9+	9+	9+	9+	9+	9+	a	9
FR = 39	9+	9	9+	9	8	4	2	2	4	5	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9	9 +	9	8
FJL = 40	,	,	3+	6	9	9	9	9	9+	9+	9	1		3+	3+	9+	3+	3+		2		3	0	0
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At 00 UTC W6 is S9, but JAs would be louder at S9+, as is W9. Europe is weak but SA is strong. Too much competition.



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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		UTC	>																						
No No No No No No No No	Zone	0.0	01	0.2	03	04	0.5	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No 10 10 10 10 10 10 10 1	KL7 = 01	9+	9+	9	9	8	5	-	-	-	-	-	-	-	1	2	1	-	-	-	-	5	-	-	5
No continue	VO2 = 02	2	4	2	1	1	-	-	-	-	-	-	4	9	9+	8	8	7	1	4	7	6	3	-	2
H3 = 05 8 7 5 3 3 2 1 1 1 8 8 9+ 8 6 1 2 2 5 4 KE1 = 06 9 8 8 3 2 1 4 6 7 6 4 5 8 9 9 8 6 1 2 2 5 4 TI = 07 9+ 9 7 5 5 8 9 9 8 8 8 9 9 6 3 1 1 3 TI = 07 9+ 9 7 5 5 8 9 9 8 8 8 9 9 6 3 1 1 3 7 3 - 1 FYP2 = 08 5 2 1 1 4 2 7 9 9 8 7 1 1 1 2 6 3 - 1* HC = 10 9+ 7 7 5 1 1 1 5 5 5 6 7 9 9+ 9 5 1* 1 1 2 6 3 - 1* HC = 10 9+ 7 7 5 5 1 1 1 5 5 5 6 7 9 9+ 9 5 1* 1 5 8 9 9 8 8 2 2 1 5 8 9 9 8 9 8 8 2 2 1 5 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	W6 = 0.3	9	8	8	2	-	-	-	-	-	-	-	-	1	-	-	-	1	5	7	6	1	-	-	7
No. No.	W9 = 04	9+	8	-2	-	-	-	-	-	-	1	3	-1	- 3	5	8	8	-2	-	1	3	3	-	-	6
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VP2 = 08	XE1 = 06	9	8	3	-	-	-	-	2	4	6	7	6	4	5	8	6	1	1	-	-	-	-	-	3
P4 = 09 8 6 1 1 1 4 2 7 7 9 9 8 7 1 1 1 2 6 3 - 1* HC = 10 9+ 7 7 5 1 1 1 5 5 6 7 9 9 9 9 5 1 1 2 - 2 - 2 PY1 = 11 9 9+ 9 9 9 1 1 2 9 7* 2* 1 5 8 9 9 9 9 9 9 8 8 7 2* 1 5 8 9 9 9 9 9 8 8 8 6 5 6 7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	TI = 07	9+	9	7	5	-	-	-	5	8	9	8	8	9	9	6	3	-	-	-	-	1	-	-	-
HC = 10	VP2 = 08	5	2	-	-	-	-	-	-	1	-	8	9	9	8	8	2	-	1	1	3	7	3	-	1
FY1 = 11 9 9+ 9 9 1 - - - 1 2 9 7* 2* - - - 1 5 8 9 9 9+ 9 <t< td=""><td>P4 = 09</td><td>8</td><td>6</td><td>1</td><td>-</td><td>-</td><td>-</td><td>1</td><td>1</td><td>4</td><td>2</td><td>7</td><td>9</td><td>9</td><td>8</td><td>7</td><td>1</td><td>-</td><td>-</td><td>1</td><td>2</td><td>6</td><td>3</td><td>-</td><td>1*</td></t<>	P4 = 09	8	6	1	-	-	-	1	1	4	2	7	9	9	8	7	1	-	-	1	2	6	3	-	1*
CE = 12 9 8 7 2* 2 9 8 8 8 5 5 5 1 1 - 1 5 8 7 9 9 1	HC = 10	9+	7	7	5	1	1	1	5	5	6	7	9	9+	9	5	1*	-	-	-	-	2	-	-	2
No	PY1 = 11	9	9+	9	9	1	-	-	-	1	2	9	7 ★	2*	-	-	-	1	5	8	9	9+	9+	9	8
G = 14 1 6 8 9 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 8 1 1 1 1	CE = 12	9	8	7	2 *	-	-	-	-	2	9	8	8	5	5	-	-	1	-	1	7	7	8	7	9
I = 15	LU = 13	9+	9	8	- 6	_1	_	_	_	1	2	9	5*	5∗	_	_	1	1	1	-5	- 8	7	9	9	9
UA3 = 16	G = 14	1	-	-	-	-	-	6	8	9	9	9+	9+	9+	9+	9+	9+	8	1	-	-	-	-	1	1
UN = 17 - 9+ 9+ 9+ 9+ 9+ 9 + 9 + 9 + 9 + 9 + 9	I = 15	4	4	-	-	2	8	8	7	7	7	9	9	9+	9+	9+	9+	9	8	4	2	2	8	4	1
UA9 = 18	UA3 = 16	2	-	-	8	8	9	9	9	9+	9+	9+	9+	9+	9	8	1	-	-	2	-	5	1	-	-
UAO = 19	UN = 17	-	9+	9+	9+	9+	9	9	9	9+	9+	9+	9+	9+	9+	8	5	8	7	5	- 6	1	-	-	-
4X = 20 - - - 7 9+ 9 9 6 6 8 9 9+	UA9 = 18	5	3	9+	9+	9+	9	9	9+	9+	9+	4	7	9	4	-	-	-	-	-	-	1	-	-	-
HZ = 21	UA0 = 19	9+	9+	9+	9	9	9	9	9+	9+	5	6	9	5	-	-	-	-	-	-	-	-	-	-	-
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T = 23	HZ = 21	-	-	9+	9+	9	9	8	8	8	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9	8	9	8	1
VS6 = 24	VU = 22	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8
HS = 26	JT = 23	7	9+	9+	9+	9+	9	9	9+	9+	9+	9+	9+	9	4	9	8	7	4	4	7	5	-	-	-
HS = 26	VS6 = 24	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	9	5	-	-	4
DU = 27 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+	JA1 = 25	9+	9+	9+	9	9	9	9	9+	9+	9+	9+	5	9	9	3	-	-	-	-	-	-	-	-	8
YB = 28	HS = 26	2	2	5	5	2	1	1	2	3	5	5	3	5	3	2	2	2	3	3	3	3	3	3	2
VK6 = 29 9+ 9+ 9+ 9+ 8 7 3 7 8 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+	DU = 27	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	7	-	1	9+
VK3 = 30 9 8 7 6 4 4 5 8 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 9 9 9 8 6 6 6 9 KH6 = 31 5 4 4 5 5 6 8 9 9 9 9 9 9 9 9 9 9 8 5 9 8 1 - 3 7 KH8 = 32 2 1 2 1 2 4 7 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9	YB = 28	4	9	9+	9+	9+	9+	9+	9+	9	9+	9+	9+	9+	9+	9+	9+	8	9+	9+	9+	9+	9+	9	9+
KH6 = 31	VK6 = 29	9+	9+	9+	8	7	3	7	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8	8	9+
KH8 = 32	VK3 = 30	9	8	7	6	4	4	5	8	9	9+	9+	9+	9+	9+	9+	9+	9+	9	9	9	8	6	6	9
CN = 33 5 9 7 1 8 6 6 6 9 7 7 8 9 9 + 9 + 9 + 9 + 9 + 9 + 9 + 9 + 9 +	KH6 = 31	5	4	4	5	5	6	8	9	9	9	9	9	9	9	8	5	-	-	9	8	1	-	3	7
SU = 34 2 9+ 9 8 6 7 8 8 9 9+ 9+ 9+ 9+ 9 9 7 5 2 2 3 2 6W = 35 8 9+ 9+ 9+ 7 5 3 9 4* 3 4 5 8 9 9 9+ 9+ 9+ 9+ 9+ 9 9 9 7 5 2 2 3 2 6W = 35 8 9+ 9+ 9 4 9 6 4 3 4 4 4 5 8 9 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 7 5 2 = 37 - 4 6 9 8 7 5 4 4 4 4 5 8 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 6 1 2 5 6 38 9+ 9 9 9 9 8 7 5 3 4 4 5 7 9 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 7 6 1 2 5 6 38 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	KH8 = 32	2	1	2	1	2	4	7	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	8	2	1	5	4
6W = 35 8 9+ 9+ 7 5 3 9 4* 3 4 5 8 9 9 9+ 9+ 9+ 9+ 9+ 9 9 7 D2 = 36 5 9+ 9 4 9 6 4 3 4 4 4 5 8 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9 9 7 EXECUTE: 37 - 4 6 9 8 7 5 4 4 4 5 8 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+	CN = 33	5	9	7	1	-	-	8	6	6	9	7	7	8	9	9+	9+	9+	9+	9+	9+	9+	8	5	2
D2 = 36 5 9+ 9 4 9 6 4 3 4 4 4 5 8 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 7 5Z = 37 - 4 6 9 8 7 5 4 4 4 5 8 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 6 1 ZS6 = 38 9+ 9 9 9 8 7 5 3 4 4 5 7 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 FR = 39 9 9 9+ 9 8 4 2 2 4 5 8 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 8 8 FJL = 40 6 9 9 9 9 9 9+ 9+ 9 9 1 1 1 2 2 Zone 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 UTC> * = Longpath	SU = 34	_	-	-	2	9+	9	8	6	7	8	8	9	9+	9+	9+	9+	9	9	7	5	2	2	3	2
D2 = 36	6W = 35	8	9+	9+	7	-	_	_	5	3	9	4 *	3	4	5	8	9	9	9+	9+	9+	9+	9+	8	8
SZ = 37 - 4 6 9 8 7 5 4 4 4 5 8 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 9 6 1 ZS6 = 38 9+ 9 9 9 9 8 7 5 3 4 4 5 7 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 FR = 39 9 9 9+ 9 8 4 2 2 4 5 8 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9	D2 = 36	5	9+	9	4	9	6	4	3	4	4	4	5	8	9	9	9+	9+		9+	9+	9+	9+	9	7
ZS6 = 38 9+ 9 9 9 8 7 5 3 4 4 5 7 9 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 9				_	_			_			_				_	9+								6	1
FR = 39 9 9 9+ 9 8 4 2 2 4 5 8 9 9+ 9+ 9+ 9+ 9+ 9+ 9+ 9 9 8 8 FJL = 40 6 9 9 9 9 9+ 9+ 9 1 1 1 2 2 Zone 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 UTC> * = Longpath		9+	_		_			_	_	_	_	_											-	9	
FJL = 40 6 9 9 9 9 9 9 9 9 9 1 1 1 2 2 Zone 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 UTC> * = Longpath			-	-	_		-	_	_	_	-	_	-	-	-									_	-
Zone 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 UTC> * = Longpath		-	-									-			- '	- '	- '	- '	- '				-	-	-
UTC> * = Longpath		0.0	01	0.2	-			_	_			-	_	_	13	14	15	16	17				21	22	23
						•																			
Expected signal levels using 1500 W and 3-element Yagis at 100 feet at each station.	Expected			evel	s us	ing	1500					Yaq	is a	t 10	0 fe	et a	t ead	ch si	tati	on.					

At 18 UTC, the JAs and Europeans would be weak. 18 UTC is the best time for W6 to work Thailand without interference. 45

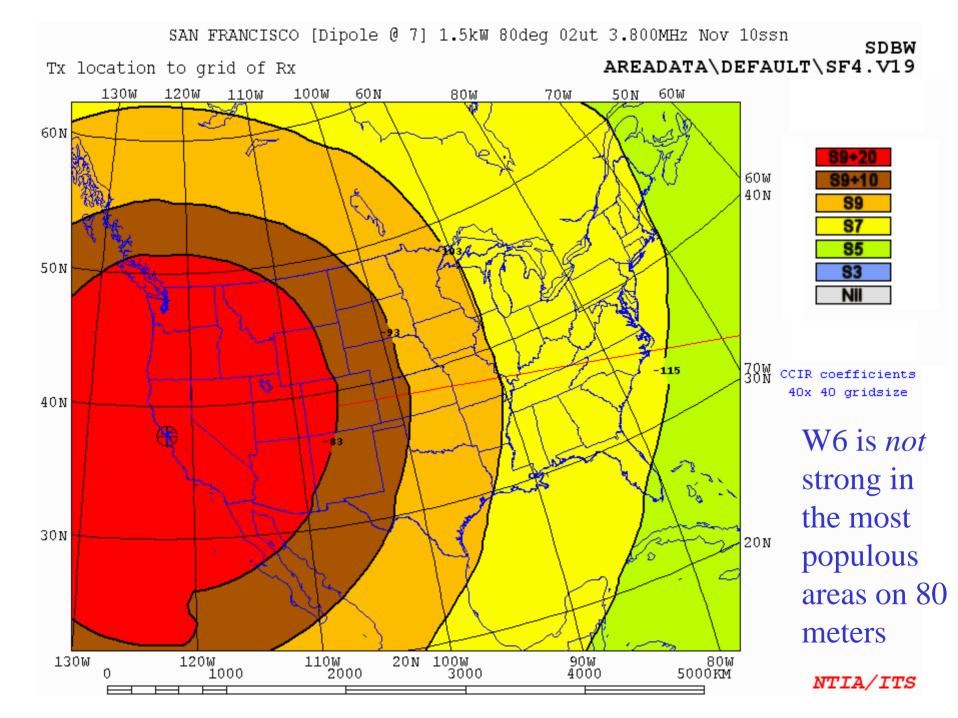
Visualization — Area Coverage Maps

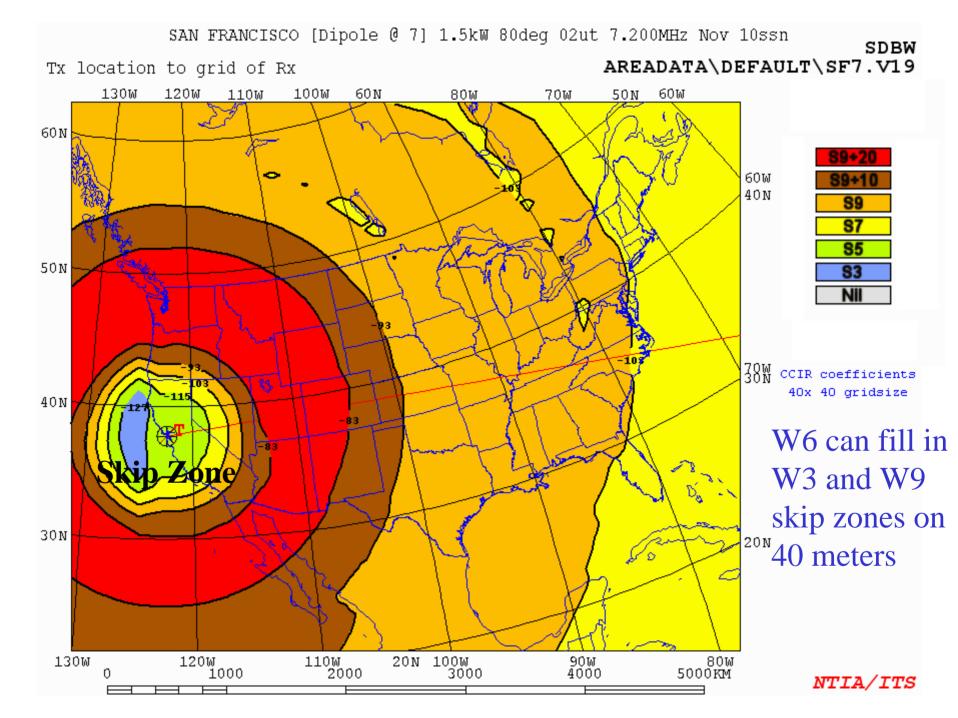
The following area-coverage maps are for San Francisco, CA, during a period of low solar activity in November (think ARRL Sweepstakes contest).

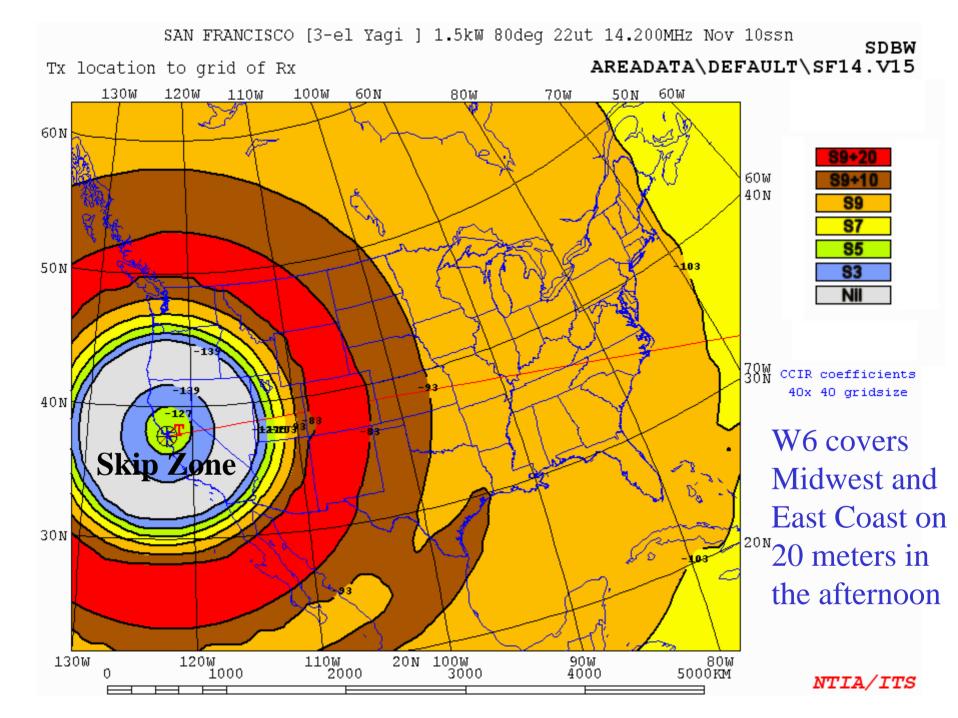
Visualization — Area Coverage Maps

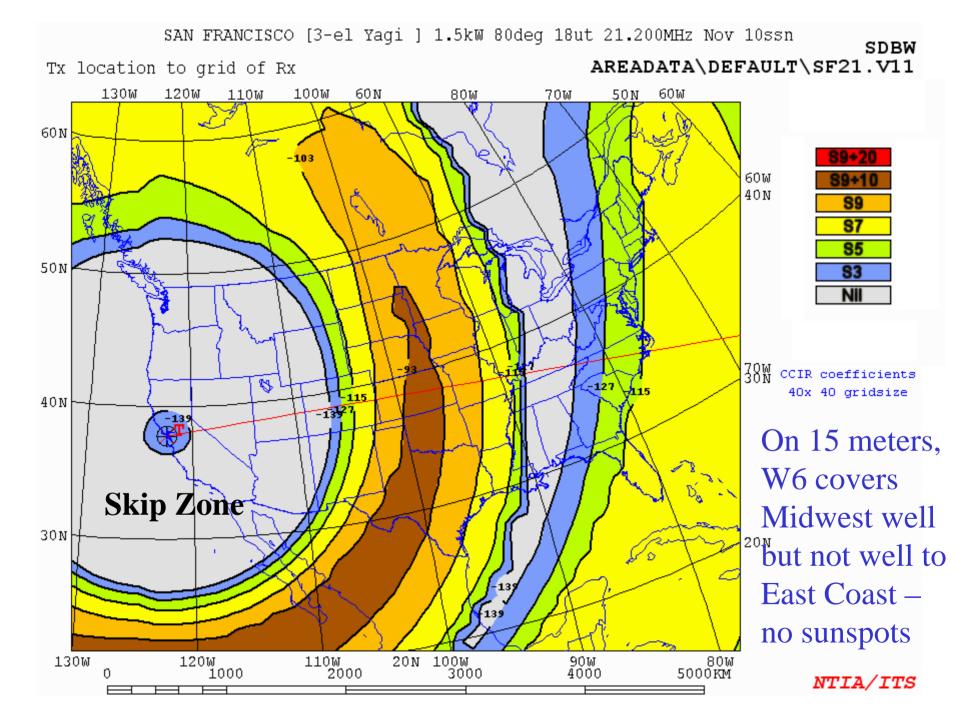
The following area-coverage maps are for San Francisco, CA, during a period of low solar activity in November (think ARRL Sweepstakes contest).

The maps were created using *VOAAREA*, part of the *VOACAP* software suite.









What About Field Day 2008?

• Predicted solar conditions will still be very low, and 80, 40 and 20 meters should be the money bands.

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What About Field Day 2008?

- Predicted solar conditions will still be very low, and 80, 40 and 20 meters should be the money bands.
- Signal strengths for 100 W vs 1500 W in the previous area-coverage maps will be about two S-units down.
- Big antennas and/or hilltop locations will be best for 2008 Field Day. Surprise...

	OIC	>																							
Zone	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
KL7 = 01	-	-	-	6	7	8	9	9	9	9	9	9+	9+	9	8	4	-	-	-	-	-	-	-	-	
VO2 = 02	-	2	5	6	8	8	8	8	9	8	5	4	1	-	-	-	-	-	-	-	-	-	-	-	
W6 = 03	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	
W9 = 04	1	8	9	9	9+	9	9+	9+	9+	9+	9+	9+	9	8	-	-	-	-	-	-	-	-	-	-	
W3 = 05	2	5	7	8	9	9	9	9	9	9	9	8	7	3	-	-	-	-	-	-	-	-	-	-	

	UTC	>																						
Zone	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KL7 = 01	6	8	9	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8	6	5	3	2	2	3	4
VO2 = 02	7	8	9	9+	9+	9+	9+	9	9	9	9	9	8	6	3	1	-	-	-	-	-	-	2	3
W6 = 03	9+	9+	9+	9+	9+	9+	9	8	6	6	7	5	5	7	7	9	9+	9+	9+	9+	9+	9+	9+	9+
W9 = 04	9	9+	9+	9+	9+	9+	9+	9+	9+	9	9	8	9+	9+	9	8	6	4	1	1	2	3	6	8
W3 = 05																								

	UTC	>																						
Zone	00	01	02	03	04	05	06	07	8 0	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KL7 = 01	1	1	2	5	6	5	4	4	3	2	1	-	-	-	1	2	4	5	5	5	5	4	4	3
VO2 = 02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W6 = 03	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	6
W9 = 04	6	8	9	8	5	5	4	2	-	-	-	-	-	-	2	5	5	5	4	3	2	1	2	3
W3 = 05	7	8	7	5	1	1	-	-	-	-	-	-	-	1	2	5	5	5	5	6	6	5	5	6

40 Meters: Jun., CA (San Francisco), for SSN = Very Low, Sigs in S-Units. By N6BV, ARRL.

20 Meters: Jun., CA (San Francisco), for SSN = Very Low, Sigs in S-Units. By N6BV, ARRL.

	OTC	>																						
Zone	00	01	02	03	04	05	06	07	8 0	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KL7 = 01	1	1	2	5	6	5	4	4	3	2	1	-	-	-	1	2	4	5	5	5	5	4	4	3
VO2 = 02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W6 = 03	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	6
W9 = 04	6	8	9	8	5	5	4	2	-	-	-	-	-	-	2	5	5	5	4	3	2	1	2	3
W3 = 05	7	8	7	5	1	1	-	-	-	-	-	-	-	1	2	5	5	5	5	6	6	5	5	6

Summary

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- Ionospheric propagation of HF signals is very complicated.
- But that just makes it more interesting and exciting for an Amateur Radio operator.
- There are propagation-prediction programs that can help, but there's nothing like actually getting on the air and hearing what's coming in!