Propagation Predictions for Newbies (and OTs too)

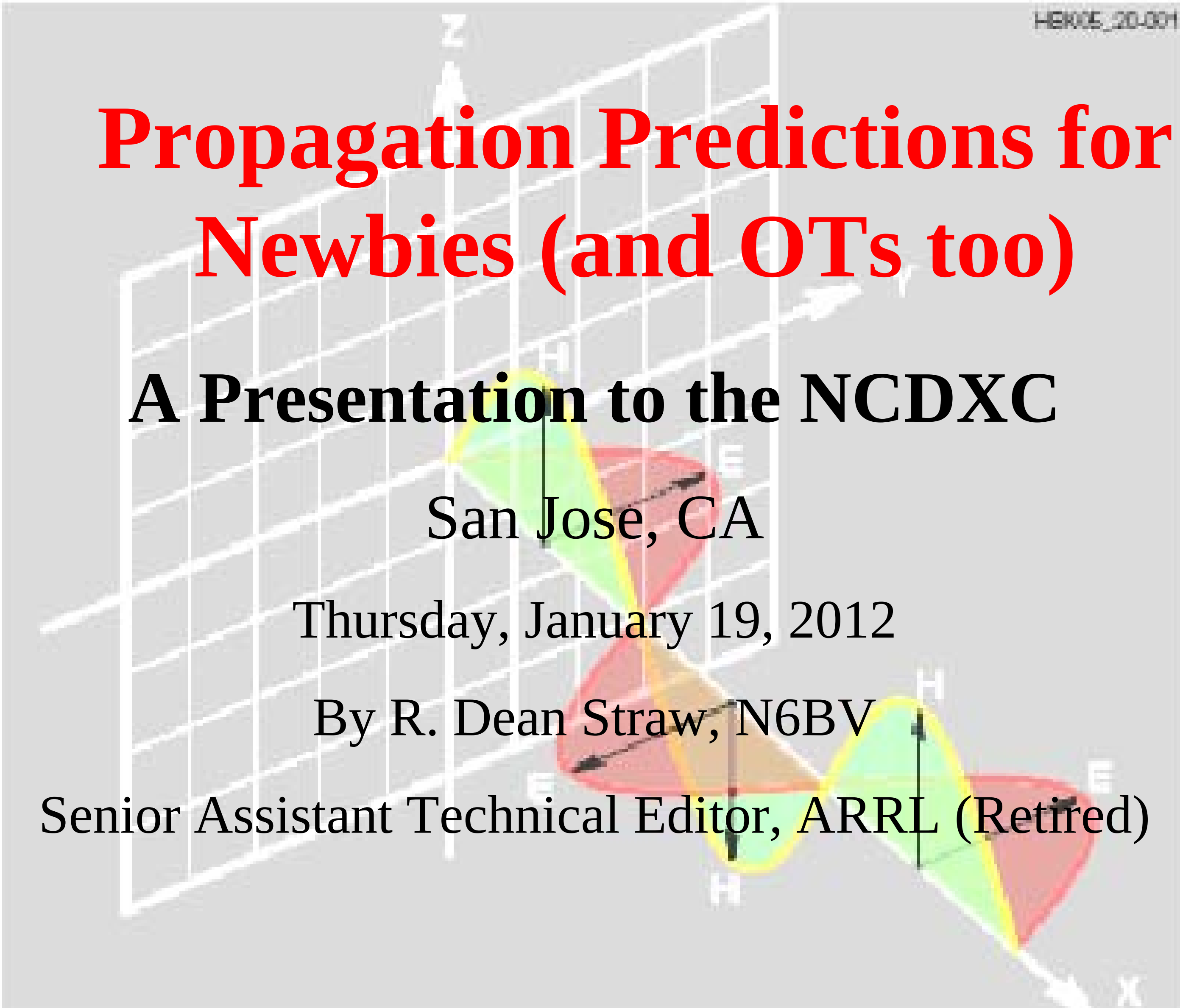
A Presentation to the NCDXC

San Jose, CA

Thursday, January 19, 2012

By R. Dean Straw, N6BV

Senior Assistant Technical Editor, ARRL (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."

Albert Einstein — Explaining How Radio Works.

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“Do you understand this?”

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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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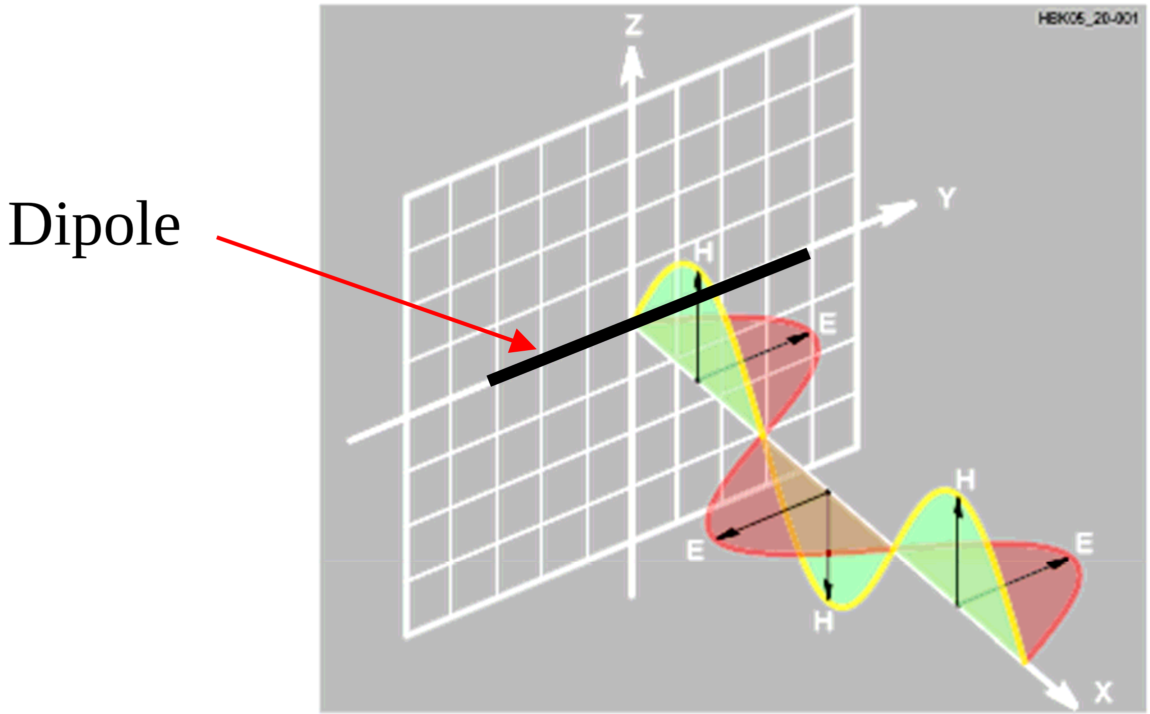
- My usual answer: “It’s magic!”
- However, sometimes I’ll say: “If you wiggle an electron it will produce an electromagnetic field that propagates away from the electron.”
- But all in all, I prefer Einstein’s cat!

HF Radio Wave Propagation

- Feline humor aside, I’m splitting this talk into two parts:
  - The mechanics of HF propagation (the basics: Propagation 101)
  - Predicting HF propagation (advanced topics: Propagation 201)

The Mechanics of HF Propagation (the basics: Propagation 101)

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

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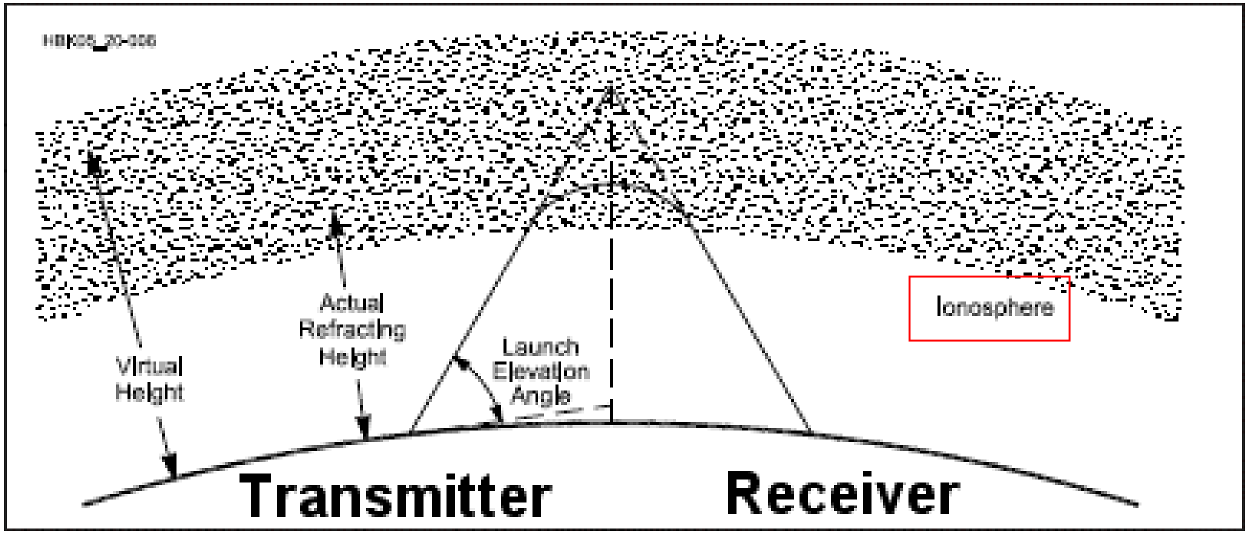
What we need is a “mirror” above the Earth to bounce signals all around the world.

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



So,What is the *Ionosphere*?

- The Sun bathes the Earth in a number of different forms of radiation.
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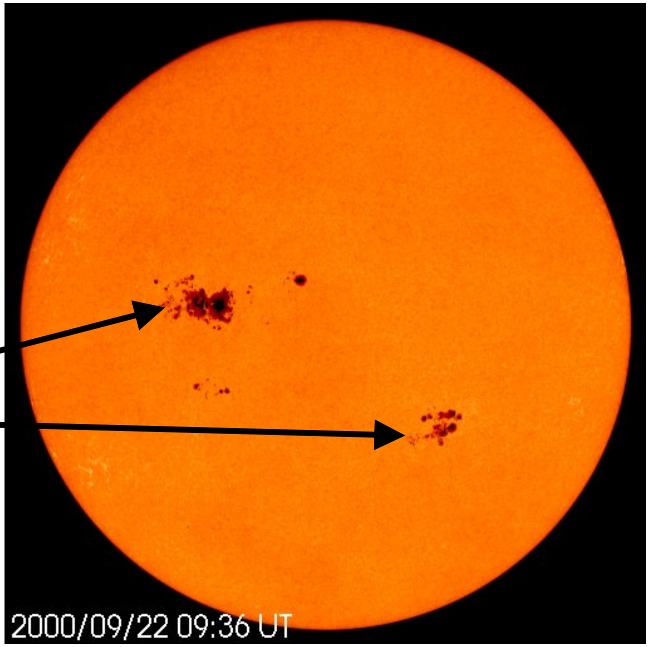
  - Visible light.
  - Infrared (heat).
  - X-rays.
  - Ultraviolet (UV) and Extreme UV (EUV).

The Sun's Production of UV

Lots of big sunspots in 2000



(Courtesy: NASA)

When there are sunspots, the Sun ionizes the Earth's ionosphere strongly with UV, promoting good propagation on the upper HF bands.

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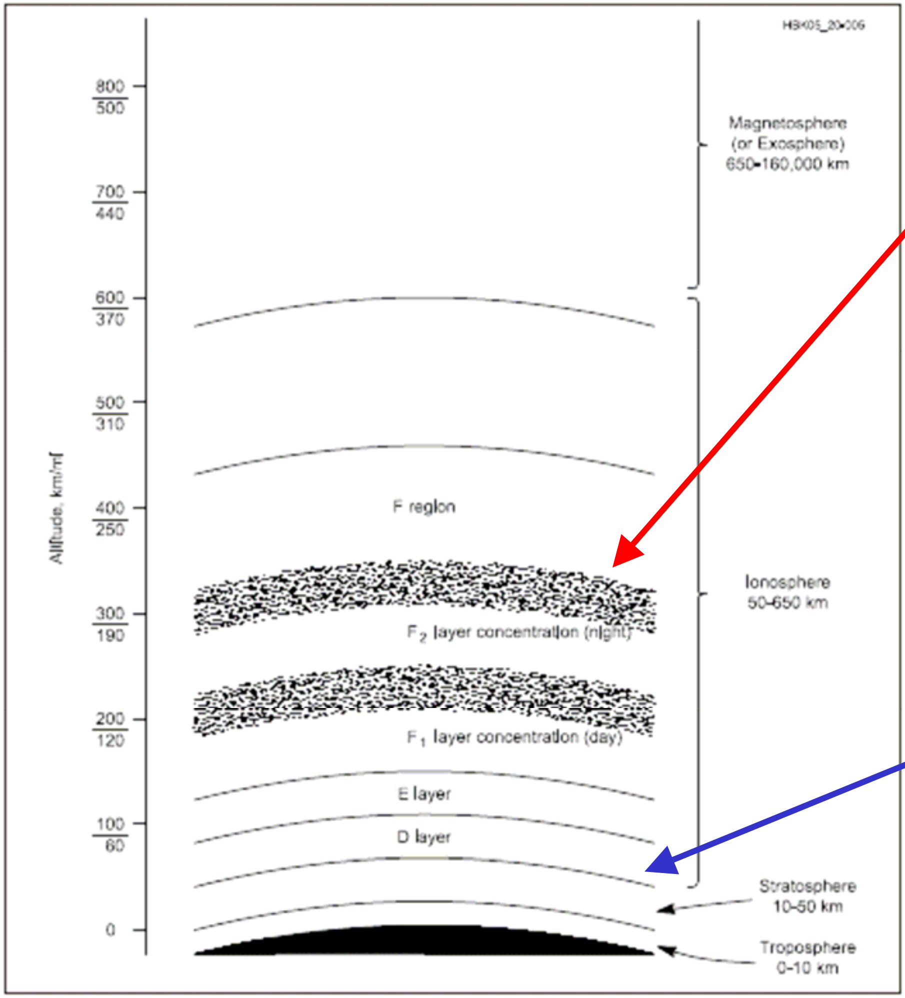
- Radiation from the Sun creates different *regions* in the ionosphere by stripping off electrons from the various types of air molecules there, creating ions.
- The *free electrons* affect radio waves passing through the ionospheric regions.
- The rate of re-combination of free electrons with positive ions depends on the region.

Regions in the Atmosphere



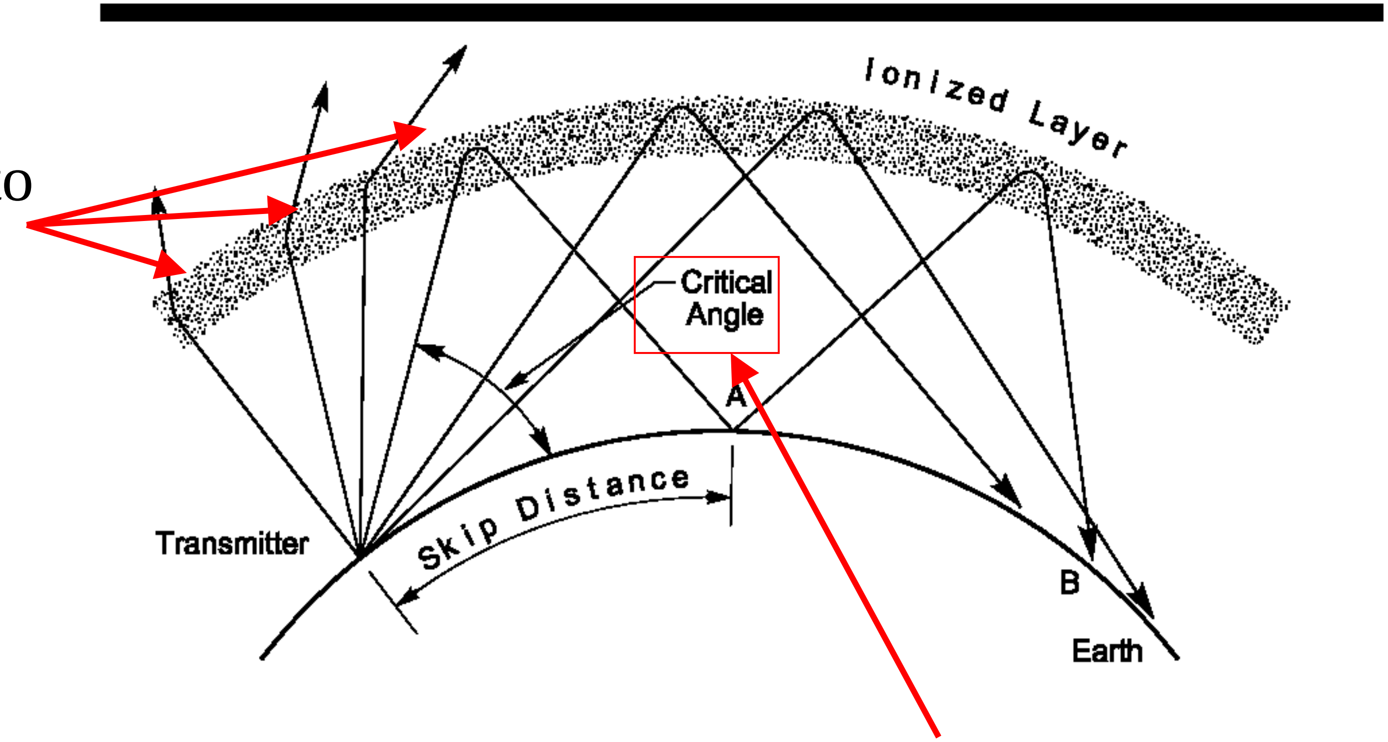
The F_2 region is responsible for most of the long-distance propagation at HF because it's the highest region above Earth and because it has the most free electrons.

The D region is a "bad guy," absorbing lower-frequency waves

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

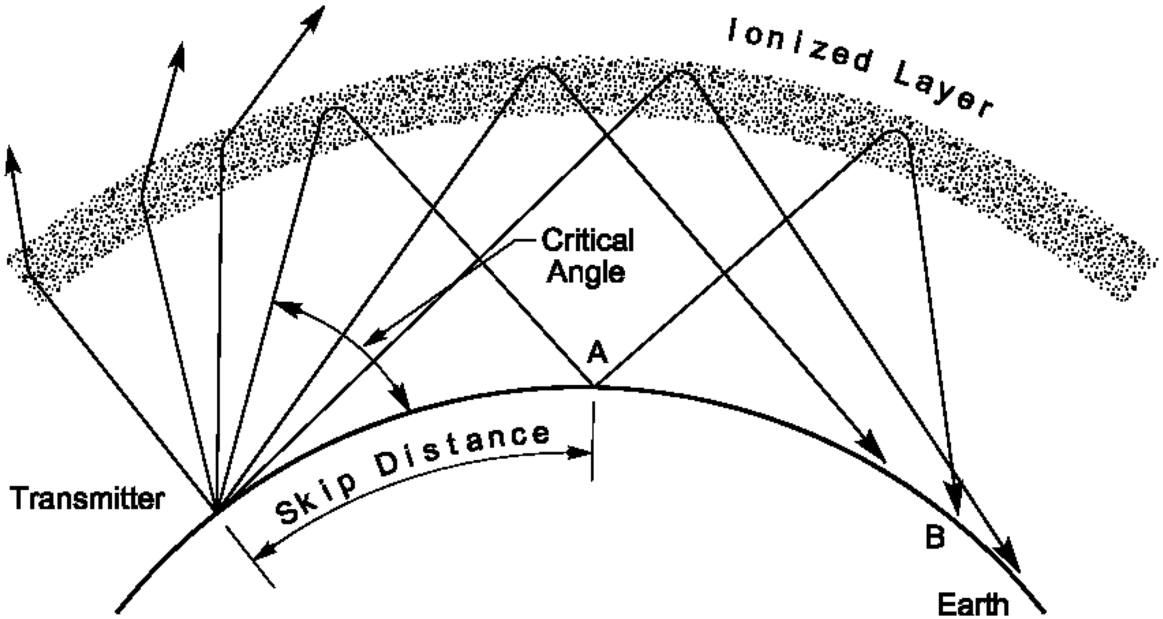
Bending Around the Earth’s Curvature

Lost to space

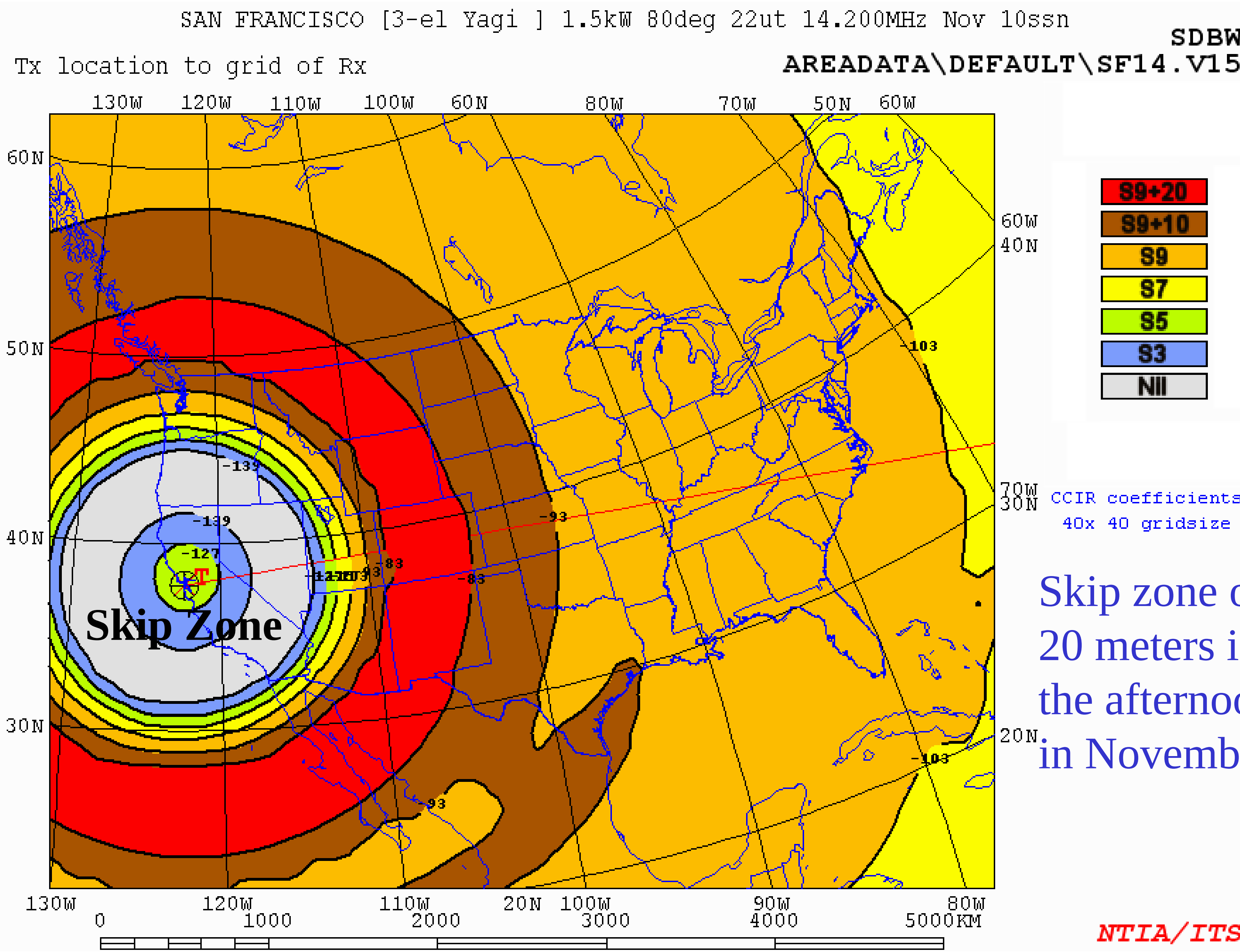


Behavior of waves encountering a simple curved *ionospheric layer* over a curved Earth. Waves higher than the *Critical Angle* are lost to space. Lower-angle waves are refracted and bent back down to Earth. (From *The ARRL Antenna Book*, 21st Ed.)

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.)



Skip zone on 20 meters in the afternoon in November

What Influences 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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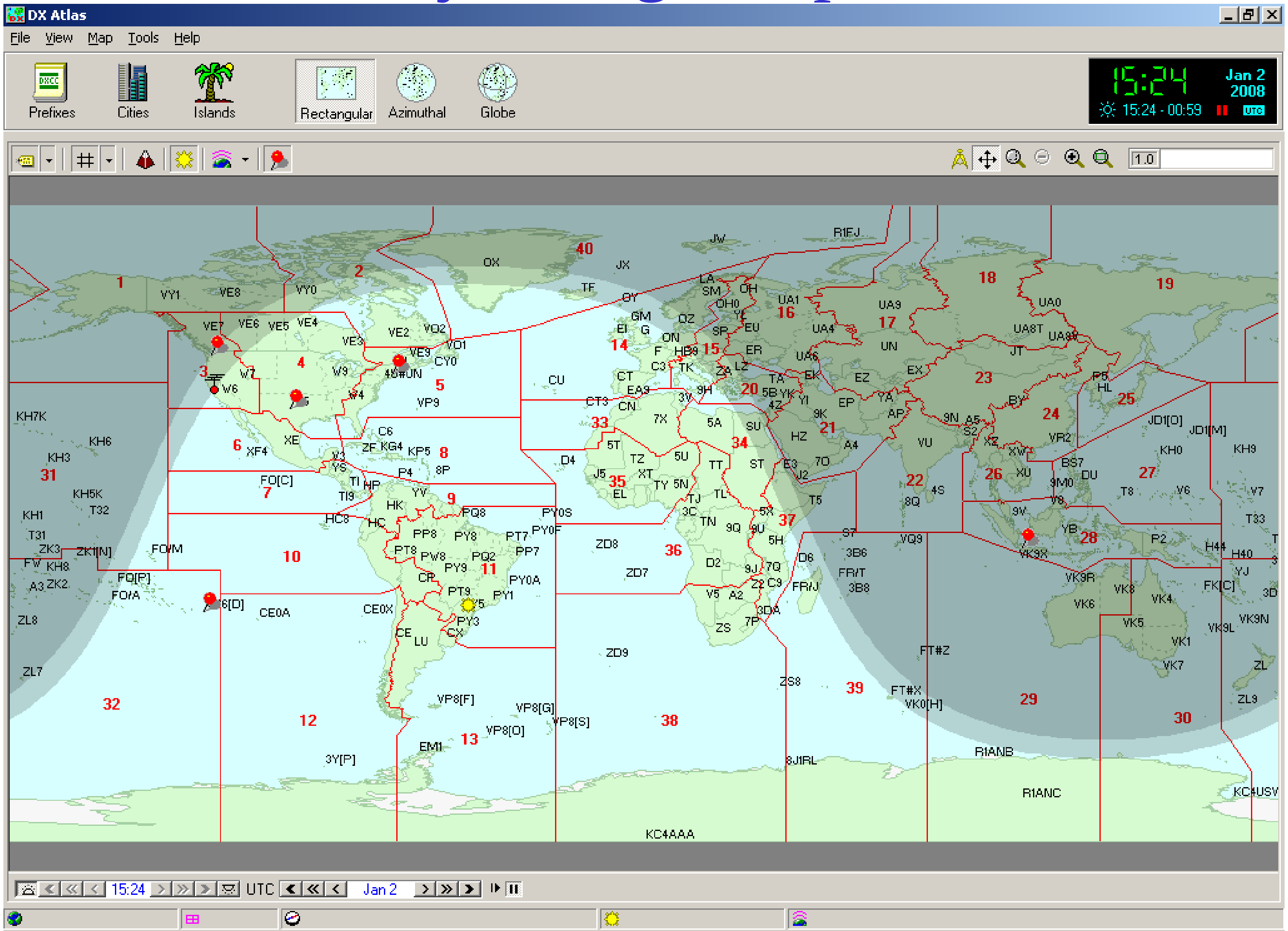
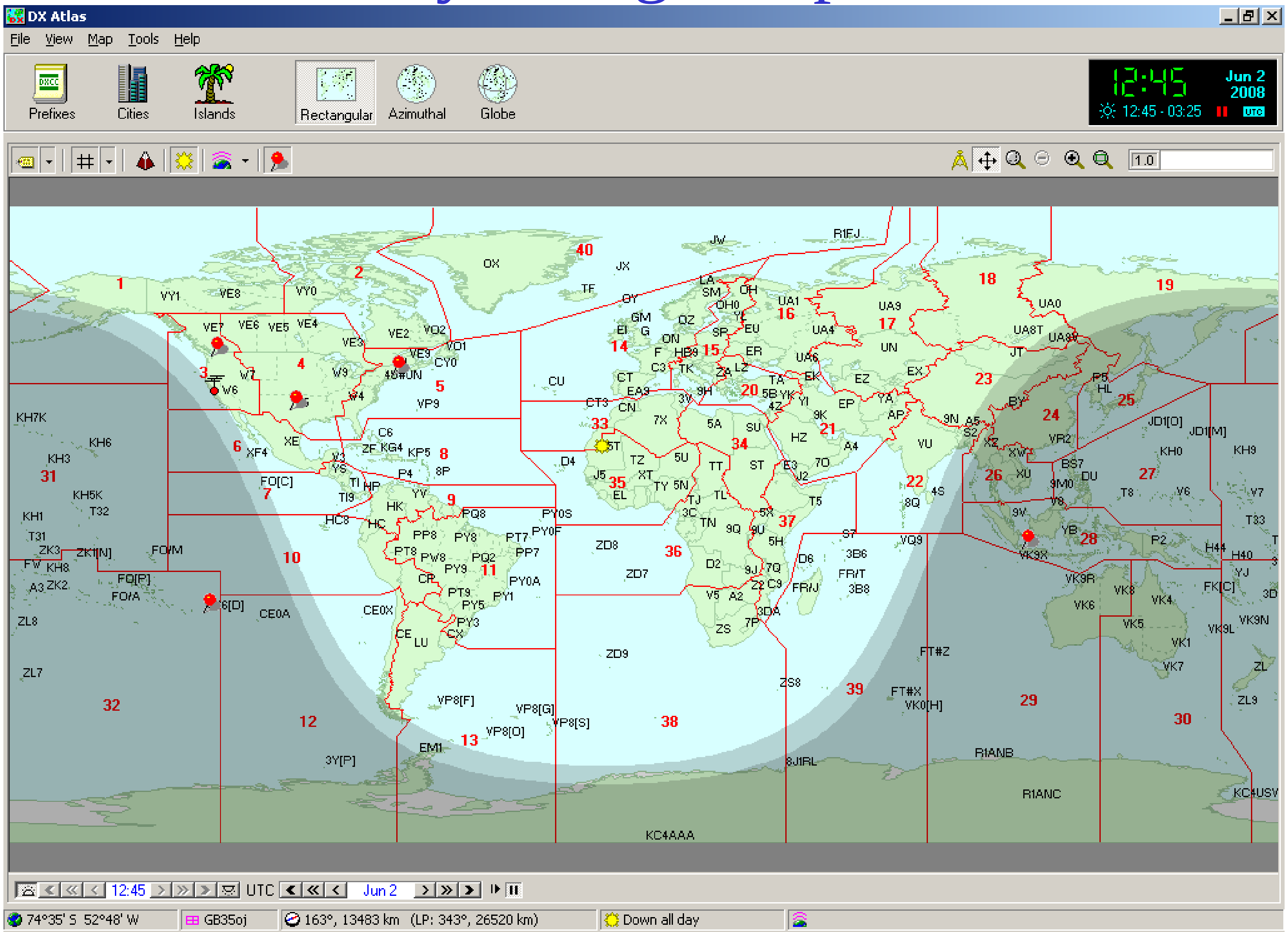


Sunrise, W6 in January

DX Atlas

• Transition day-to-night depends on month

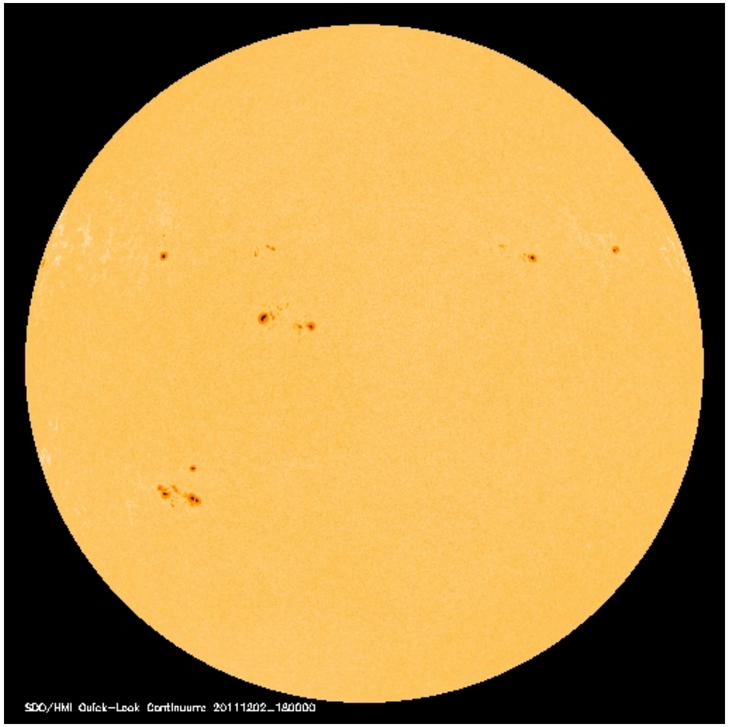


Sunrise, W6 in June

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).

- The state of the ionosphere.
    - The 11-year solar cycle (heading to max.).



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  - The Earth’s geomagnetic field.
    - Affected by solar flares

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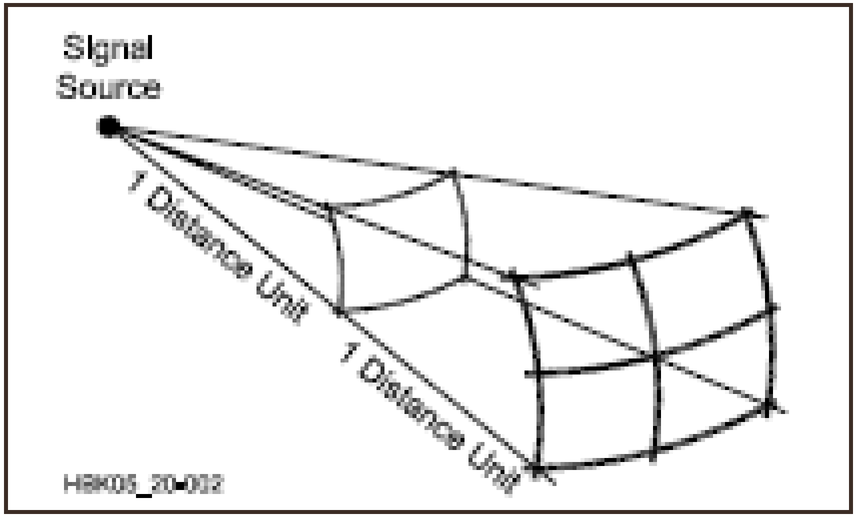
  - The 11-year solar cycle (heading to max.).
  - The Earth’s geomagnetic field.
    - Affected by solar flares.
    - Affected by solar Coronal Mass Ejections (CMEs) and the solar wind.

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?

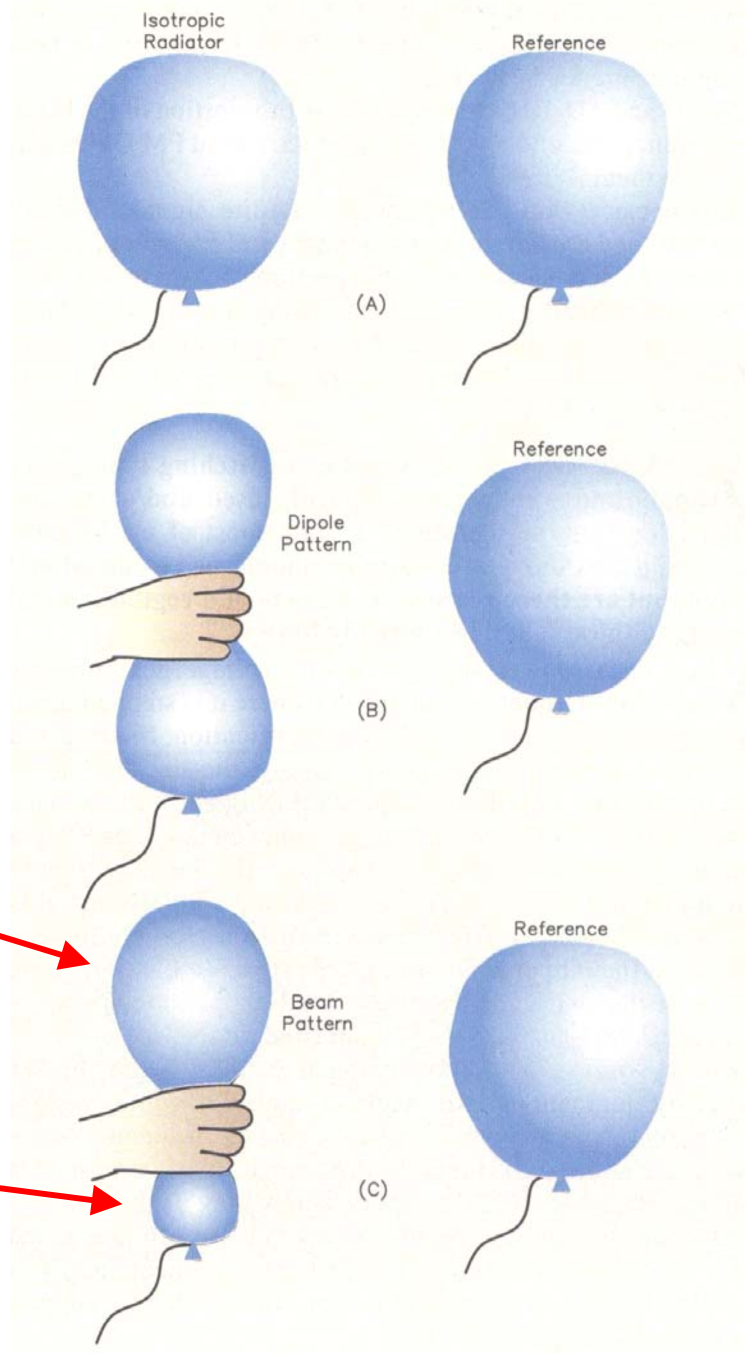
"It is important to remember this so-called *spreading loss* when antenna performance is being considered. Gain can come only from narrowing the radiation pattern of an antenna, which concentrates the radiated energy in the desired direction."

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

Antenna Gain

Like squeezing a balloon...

More signal in one direction means less signal in other directions



Influences on Propagation Coverage

- Frequency, and month/day/hour.
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- The launch elevation angle.
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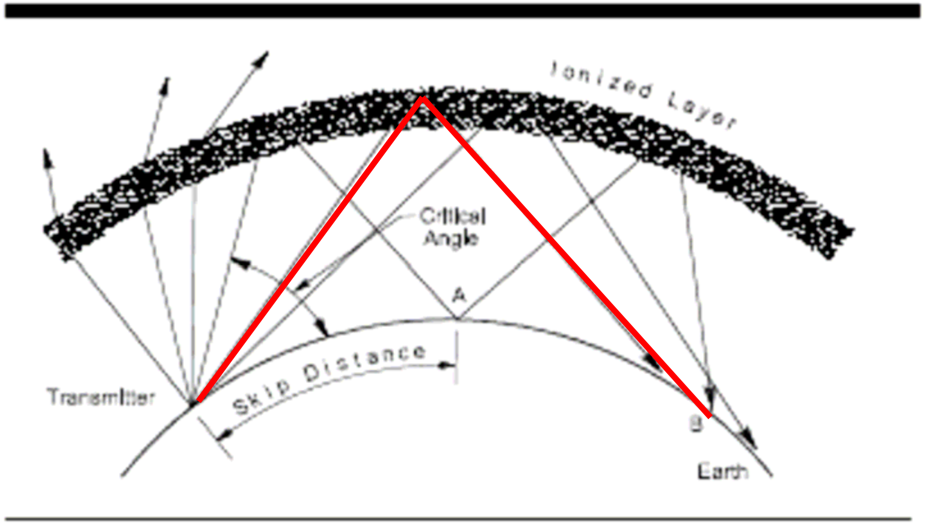
Influences on Propagation Coverage

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



Influences on Propagation Coverage

- The launch elevation angle.
  - 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 (Near Vertical Incidence Skywave) techniques, requires low horizontal antennas that "warm the clouds."

Influences on Propagation Coverage

- Frequency, and month/day/hour.
- The state of the ionosphere.
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- Noise level at receiver (signal-to-noise ratio).
  - If there is local noise (QRN) or strong interference (QRM) at a distant receiver, your signal can't be heard.

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- Noise level at receiver (signal-to-noise ratio).
  - 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.

Predicting HF Propagation
(advanced topics: Propagation 201)

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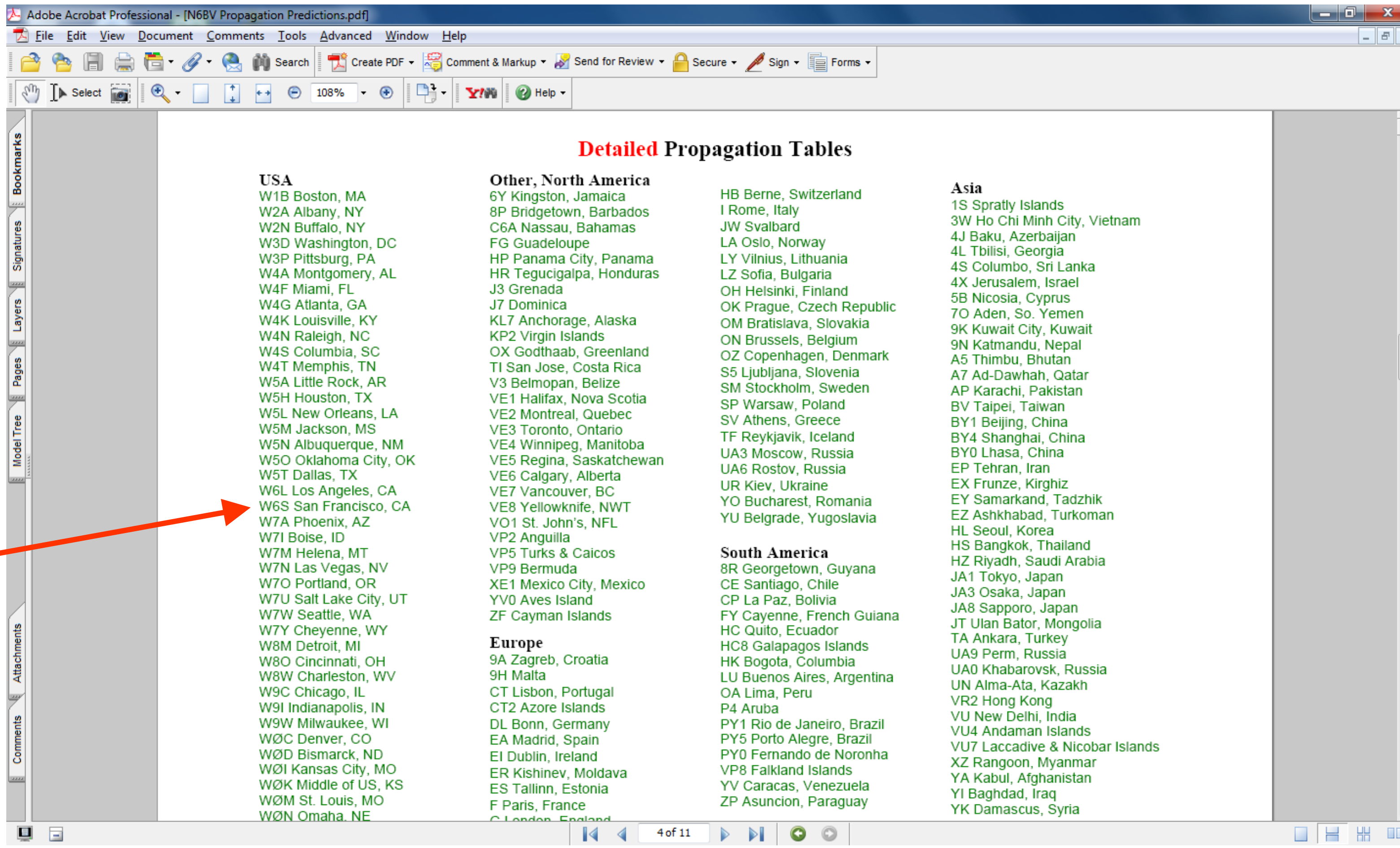
- The following prediction tables come from the *N6BV Propagation* tables.

N6BV Propagation Predictions



Detailed Propagation Tables

USA
W1B Boston, MA
W2A Albany, NY
W2N Buffalo, NY
W3D Washington, DC
W3P Pittsburg, PA
W4A Montgomery, AL
W4F Miami, FL
W4G Atlanta, GA
W4K Louisville, KY
W4N Raleigh, NC
W4S Columbia, SC
W4T Memphis, TN
W5A Little Rock, AR
W5H Houston, TX
W5L New Orleans, LA
W5M Jackson, MS
W5N Albuquerque, NM
W5O Oklahoma City, OK
W5T Dallas, TX
W6L Los Angeles, CA
W6S San Francisco, CA
W7A Phoenix, AZ
W7I Boise, ID
W7M Helena, MT
W7N Las Vegas, NV
W7O Portland, OR
W7U Salt Lake City, UT
W7W Seattle, WA
W7Y Cheyenne, WY
W8M Detroit, MI
W8O Cincinnati, OH
W8W Charleston, WV
W9C Chicago, IL
W9I Indianapolis, IN
W9W Milwaukee, WI
WØC Denver, CO
WØD Bismarck, ND
WØI Kansas City, MO
WØK Middle of US, KS
WØM St. Louis, MO
WØN Omaha, NE

Other, North America
6Y Kingston, Jamaica
8P Bridgetown, Barbados
C6A Nassau, Bahamas
FG Guadeloupe
HP Panama City, Panama
HR Tegucigalpa, Honduras
J3 Grenada
J7 Dominica
KL7 Anchorage, Alaska
KP2 Virgin Islands
OX Godthaab, Greenland
TI San Jose, Costa Rica
V3 Belmopan, Belize
VE1 Halifax, Nova Scotia
VE2 Montreal, Quebec
VE3 Toronto, Ontario
VE4 Winnipeg, Manitoba
VE5 Regina, Saskatchewan
VE6 Calgary, Alberta
VE7 Vancouver, BC
VE8 Yellowknife, NWT
VO1 St. John's, NFL
VP2 Anguilla
VP5 Turks & Caicos
VP9 Bermuda
XE1 Mexico City, Mexico
YV0 Aves Island
ZF Cayman Islands

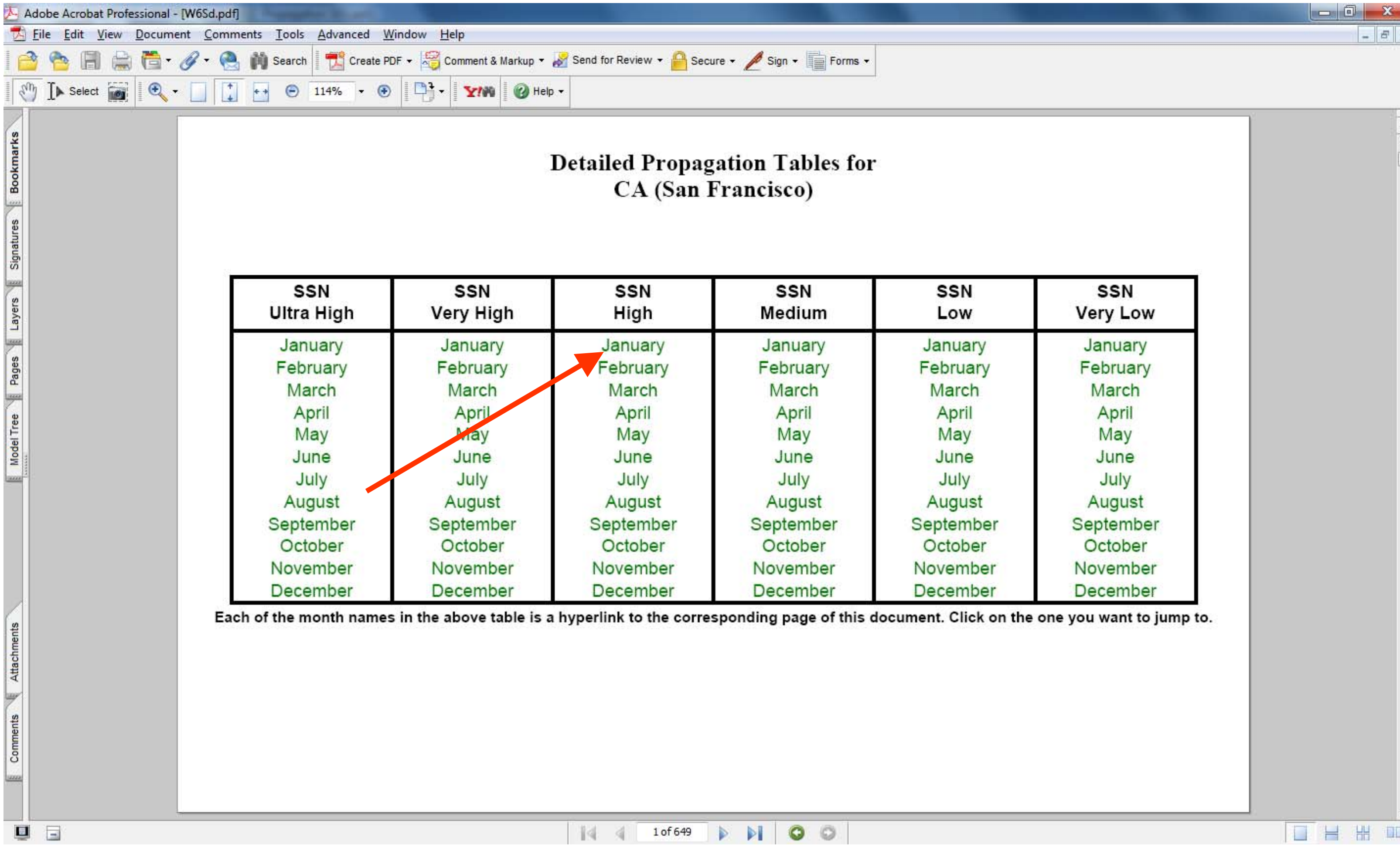
Europe
9A Zagreb, Croatia
9H Malta
CT Lisbon, Portugal
CT2 Azore Islands
DL Bonn, Germany
EA Madrid, Spain
EI Dublin, Ireland
ER Kishinev, Moldava
ES Tallinn, Estonia
F Paris, France
G London, England
HB Berne, Switzerland
I Rome, Italy
JW Svalbard
LA Oslo, Norway
LY Vilnius, Lithuania
LZ Sofia, Bulgaria
OH Helsinki, Finland
OK Prague, Czech Republic
OM Bratislava, Slovakia
ON Brussels, Belgium
OZ Copenhagen, Denmark
S5 Ljubljana, Slovenia
SM Stockholm, Sweden
SP Warsaw, Poland
SV Athens, Greece
TF Reykjavik, Iceland
UA3 Moscow, Russia
UA6 Rostov, Russia
UR Kiev, Ukraine
YO Bucharest, Romania
YU Belgrade, Yugoslavia

South America
8R Georgetown, Guyana
CE Santiago, Chile
CP La Paz, Bolivia
FY Cayenne, French Guiana
HC Quito, Ecuador
HC8 Galapagos Islands
HK Bogota, Columbia
LU Buenos Aires, Argentina
OA Lima, Peru
P4 Aruba
PY1 Rio de Janeiro, Brazil
PY5 Porto Alegre, Brazil
PY0 Fernando de Noronha
VP8 Falkland Islands
YV Caracas, Venezuela
ZP Asuncion, Paraguay

Asia
1S Spratly Islands
3W Ho Chi Minh City, Vietnam
4J Baku, Azerbaijan
4L Tbilisi, Georgia
4S Columbo, Sri Lanka
4X Jerusalem, Israel
5B Nicosia, Cyprus
7O Aden, So. Yemen
9K Kuwait City, Kuwait
9N Katmandu, Nepal
A5 Thimbu, Bhutan
A7 Ad-Dawhah, Qatar
AP Karachi, Pakistan
BV Taipei, Taiwan
BY1 Beijing, China
BY4 Shanghai, China
BY0 Lhasa, China
EP Tehran, Iran
EX Frunze, Kirghiz
EY Samarkand, Tadzhik
EZ Ashkhabad, Turkoman
HL Seoul, Korea
HS Bangkok, Thailand
HZ Riyadh, Saudi Arabia
JA1 Tokyo, Japan
JA3 Osaka, Japan
JA8 Sapporo, Japan
JT Ulan Bator, Mongolia
TA Ankara, Turkey
UA9 Perm, Russia
UA0 Khabarovsk, Russia
UN Alma-Ata, Kazakh
VR2 Hong Kong
VU New Delhi, India
VU4 Andaman Islands
VU7 Laccadive & Nicobar Islands
XZ Rangoon, Myanmar
YA Kabul, Afghanistan
YI Baghdad, Iraq
YK Damascus, Syria

240+ possible QTHs around the world

N6BV Propagation Predictions



Detailed Propagation Tables for
CA (San Francisco)

SSN Ultra High	SSN Very High	SSN High	SSN Medium	SSN Low	SSN Very Low
January	January	January	January	January	January
February	February	February	February	February	February
March	March	March	March	March	March
April	April	April	April	April	April
May	May	May	May	May	May
June	June	June	June	June	June
July	July	July	July	July	July
August	August	August	August	August	August
September	September	September	September	September	September
October	October	October	October	October	October
November	November	November	November	November	November
December	December	December	December	December	December

Each of the month names in the above table is a hyperlink to the corresponding page of this document. Click on the one you want to jump to.

Choose month, level of solar activity
(**http://www.nwra.com/spawx/ssne.html**)

N6BV Propagation Predictions

20 Meters: Jan., CA (San Francisco), for SSN = High, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

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	9+	9+	9+	9+	9+	7	2	-	-	1	5	2	-	-	-	1	7	9+	9+	9+	9+	9+	9+	9+
VO2 = 02	9+	9+	7	1	-	-	-	-	-	-	-	-	-	-	-	9	9	9	9	9	9	9	9+	9+
W6 = 03	5	6	6	7	8	8	8	8	8	8	8	8	8	8	8	7	7	5	5	7	8	8	8	6
W9 = 04	9+	9+	9+	9+	9	5	3	5	7	8	4	-	-	-	4	9+	9+	9+	9+	9	9+	9+	9+	9+
W3 = 05	9+	9+	8	2	9	8	7	9	9	9	8	1	-	6	2	9+	9	9	9	9	9	9	9+	9+
XE1 = 06	9+	9+	9+	9+	9+	9+	9	9	9+	9+	9+	9	6	8	9+	9+	9+	9	9	8	8	9	9	9+
TI = 07	9+	9+	9+	9+	8	5	2	4	6	7	2	-	-	1	9+	9	8	7	2	3	5	7	9	9+
VP2 = 08	9+	9+	9	8	6	2	1	3	6	6	2	-	-	1	9	8	7	4	3	5	7	8	9	9+
P4 = 09	9+	9+	9+	9	8	4	2	4	7	7	2	-	-	2	9	8	7	4	2	4	4	8	9	9+
HC = 10	9+	9+	9+	9+	9	8	6	7	9	7	1	-	-	4	9	8	5	2	1	1	2	5	8	9
PY1 = 11	9	9	9	9	9	9	8	8	9	9	8	5	1	2	1	-	-	-	-	-	-	2	5	8
CE = 12	9	9	9	9	9	9	9	9	9	9	8	6	1	3	7	2	1	-	-	-	-	2	4	8
LU = 13	8	9	9	9	9	9	9	9	9	9	8	5	1	4	3	1	-	-	-	-	-	3	4	7
G = 14	2	3	3	4	2	-	1*	-	-	1	-	-	-	-	-	8	8	8	8	7	4	1	-	1
I = 15	2	2	3	3	1	1*	1*	1	5	4	-	-	-	-	-	8	8	6	8	5	1	-	1	1
UA3 = 16	7	6	6	6	5	-	-	2*	1	3	-	-	-	-	-	1	8	6	4	3	2	4	5	5
UN = 17	2	5	8	8	6	-	-	-	-	-	2	-	-	-	1*	-	3	5	5	6	5	4	2	1
UA9 = 18	6	8	9	8	6	-	-	-	-	1*	1	-	-	-	1*	-	-	6	5	4	2	1	-	1
UA0 = 19	9	9	9	9	7	6	4	-	-	-	1	1	1	-	-	-	-	1	-	-	8	8	8	8
4X = 20	6	6	5	4	2	-	-	1	1	1	-	-	-	-	-	8	8	8	6	4	4	4	5	6
HZ = 21	6	4	2	6	3	1*	-	-	-	-	-	-	-	-	1*	4*	8	5	4	2	5	4	5	6
VU = 22	5	7	7	7	3	-	-	-	-	-	-	1	-	-	1*	1*	5	2	2	4	4	4	3	3
JT = 23	8	9	9	8	7	2	-	-	-	-	1	-	4	-	1*	-	-	6	5	2	1	2	4	8
VR2 = 24	8	6	5	5	5	4	2	-	-	1*	1*	1	1	-	-	-	-	4	4	-	-	-	2	6
JA1 = 25	7	7	8	8	8	6	5	-	-	-	-	4	2	-	-	-	-	-	-	-	4	8	7	6
HS = 26	5	6	5	3	1	-	-	-	-	-	1*	1*	-	1*	1*	1*	1*	8	6	2	-	-	-	5
DU = 27	4	3	2	4	4	5	4	1	-	1*	1*	-	1	-	-	-	-	9	8	-	-	1	5	4
YB = 28	8	3*	1*	-	-	-	-	-	-	-	2*	-	1	1*	-	-	1*	9	8	7	5	1	3	2
VK6 = 29	2*	1*	-	-	-	-	1	2	2	1	1	1	5	2	1*	1*	7	8	7	5	3	1	2*	2*
VK3 = 30	-	-	-	1	4	5	7	7	7	5	4	6	8	5	2*	1*	9	8	6	4	-	-	1*	-
KH6 = 31	9	9+	9+	9+	9+	8	4	9+	9	8	7	9	9	8	2	4	9+	9+	9+	9	9	8	8	9
KH8 = 32	5	6	8	9	9	9	9	9	9	8	6	8	8	7	2	1	7	9	8	6	5	4	3	3
CN = 33	3	1	1	4	5	1	1*	1*	5	5	-	-	-	-	3	7	9	9	7	7	8	7	7	5
SU = 34	7	7	6	5	5	-	1*	1	2	2	-	-	-	-	-	8	8	5	7	5	4	5	5	6
6W = 35	9	9	9	9	8	5	4	1*	5	8	1	-	-	-	2	2	2	4	4	5	6	8	8	9
D2 = 36	9	9	9	8	6	3	2	3	4	1	-	-	-	-	-	2	8	4	5	5	5	6	7	8
5Z = 37	8	8	8	4*	5	1*	-	-	-	-	-	-	-	-	-	6	6	6	4	2	5	6	7	8
ZS6 = 38	9	9	9	9	7	2	1	1	-	-	-	-	-	-	-	-	7	6*	4*	2	2	4	6	8
FR = 39	8	8	8	8	2	1*	-	-	-	-	-	1*	1*	-	2*	6*	8	8	8	4	4	5	5	8
FJL = 40	6	7	8	9	1	-	-	-	-	-	-	-	-	-	-	-	6	6	8	8	8	7	6	6
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

Expected signal levels using 1500 W and 12 dBi isotropic antennas.

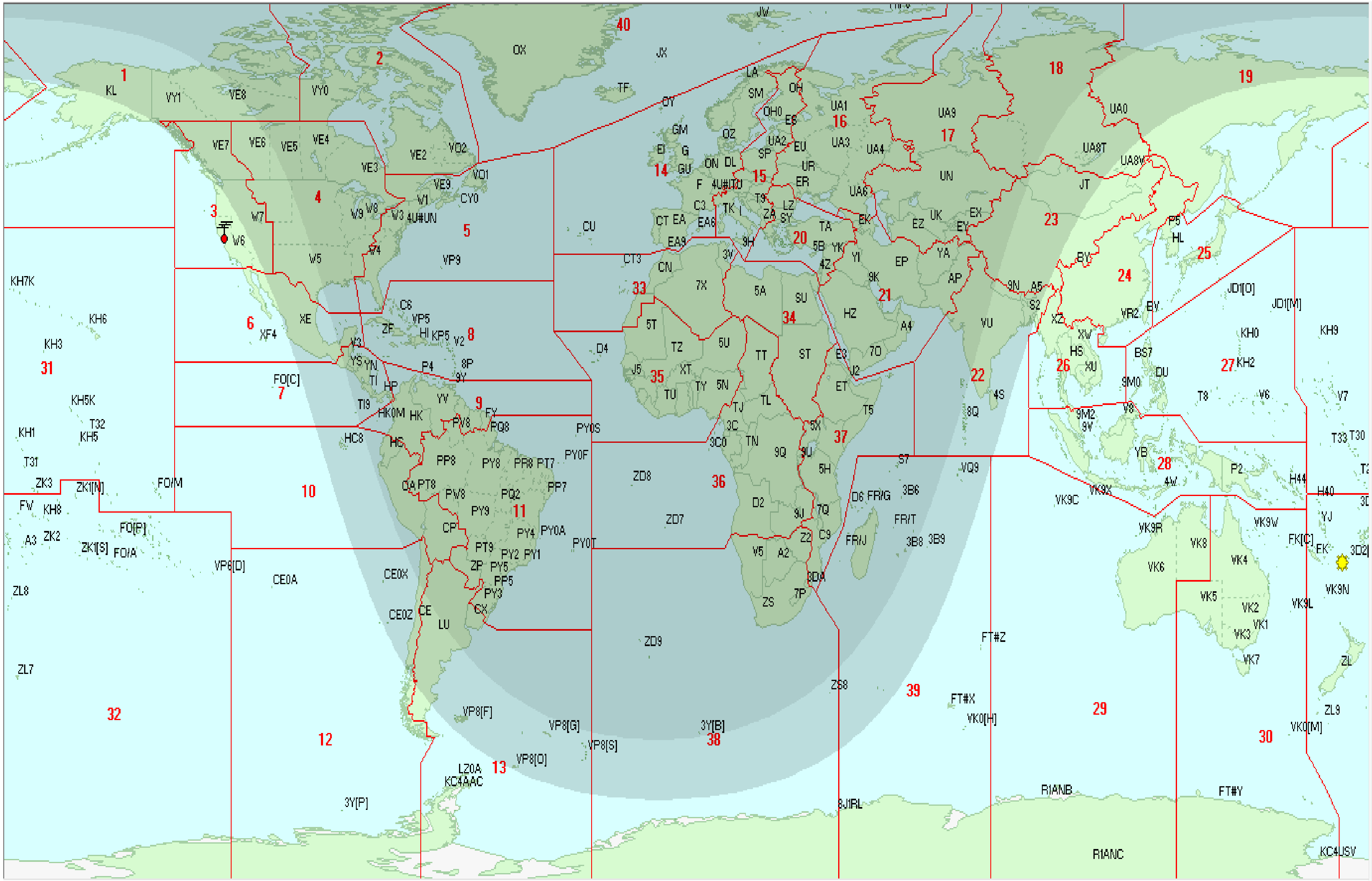
USA

EU

JA

Detailed pages for 160/80/40/30/20/17/15/12/10 meters

CQ Zones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KL
VY1
VE8
VY0
OX
JX
TF
OY
LA
SM
OH
OH0
ES
UA1
UA9
UA0
VE7
VE6
VE5
VE4
VE2
VO2
VE3
VE9
VO1
CY0
W7
W6
W9
W8
W3
4U#UN
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CU
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ON
DL
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SP
UA2
EU
UA3
UA4
UR
ER
UA6
UN
UA8T
UA8V
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C3
TK
EA6
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EA9
9H
Z3
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SV
TA
YK
4Z
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AP
9K
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A4
7O
CN
7X
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SU
5T
3V
BY
HL
JD1[O]
JD1[M]
VR2
XE
XF4
C6
ZF
VP5
HI
KP5
V2
KH7K
KH6
KH3
KH5K
KH1
T32
KH5
T31
ZK3
ZK1[N]
FO/M
FW
KH8
A3
ZK2
FO[P]
ZK1[S]
FO/A
ZL8
ZL7
VP6[D]
CE0A
CE0X
CE0Z
FO[C]
V3
YS
YN
TI
HP
P4
8P
9Y
TI9
HK0M
HK
YV
FY
PZ
PY8
PQ8
PY0S
PY0F
HC8
HC
PP8
PY8
PR8
PT7
OA
PT8
PV8
PQ2
PP7
PY9
PY4
PY0A
CP
PT9
PY2
PY1
PY0T
ZP
PY5
PP5
PY3
CX
CE
LU
D4
J5
TU
XT
TY
5N
TZ
5U
TT
ST
E3
J2
ET
TJ
TL
3C
3C0
TN
9Q
9U
5X
T5
5H
ZD8
D2
9J
7Q
D6
FR/G
3B6
FR/T
VQ9
S7
ZD7
Z2
C9
FR/J
3B8
3B9
V5
A2
3DA
ZS
7P
ZD9
ZS8
FT#Z
FT#X
VK0[H]
VU
4S
8Q
9N
A5
S2
XZ
XW
HS
XU
9M2
9V
9M0
V8
BS7
DU
YB
4W
P2
KH0
KH2
KH9
T8
V6
V7
T33
T30
VK9C
VK9X
VK9R
VK9W
H44
H40
YJ
FK[C]
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3D2
VK8
VK6
VK5
VK4
VK2
VK1
VK3
VK7
VK9L
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ZL
ZL9
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FT#Y
KC4USV
R1ANB
R1ANC
8J1RL
VP8[F]
VP8[G]
VP8[S]
VP8[O]
3Y[B]
LZ0A
KC4AAC
3Y[P]

New Detailed Prediction Tables

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

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	9	9	9	9+	9+	9+	9	9	9	9	9	9	9	8	9	9+	9	9	9	8	8	8	8	9
VO2 = 02	8	8	8	7	5	4	4	4	3	-	-	-	3	8	8	6	5	3	2	3	5	6	7	8
W6 = 03	9	8	8	5	5	5	5	5	5	5	5	5	5	5	5	5	8	9	8	9	9	9	9	9
W9 = 04	9+	9+	9+	9+	9+	9	9+	9+	9+	9+	9	9	9	9+	9+	9	8	7	5	5	7	8	8	9
W3 = 05	9	9	9	6	4	5	5	5	6	4	9	9	2	9	8	8	7	5	4	4	5	7	8	8
XE1 = 06	9	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	8	6	5	2	4	5	7	8
TI = 07	8	9	9	9	9	9	9	9	9	9	9	6	9	9	8	5	2	1	-	-	-	1	5	7
VP2 = 08	9	9	9	8	9	9	9	9	9	8	8	8	8	8	5	1	1	-	-	-	-	1	6	7
P4 = 09	8	9	9	9	9	9	9	9	9	9	8	8	8	8	6	2	1	-	-	-	-	2	6	7
HC = 10	8	8	9	9	9	9	9	9	9	8	5	4	8	8	5	2	-	-	-	-	-	-	2	7
PY1 = 11	5	7	7	7	8	8	7	8	7	6	5	5	1	-	-	-	-	-	-	-	-	-	1	2
CE = 12	5	7	8	8	8	8	8	9	9	8	8	8	6	5	1	-	-	-	-	-	-	-	-	2
LU = 13	5	7	7	8	8	8	8	8	8	7	7	7	5	1	-	-	-	-	-	-	-	-	-	2
G = 14	6	6	7	7	5	5	5	5	6	5	3	1	2	4	3	5	2	1	1	1	2	2	5	6
I = 15	6	7	7	6	5	5	7	7	6	5	2	1	2	2	2	4	4	1	1	-	1	2	4	5
UA3 = 16	5	5	5	5	6	6	6	5	4	4	3	2	2	5	6	5	4	4	2	2	3	4	5	5
UN = 17	4	2	3	3	1	2	2	1	1	2	3	4	4	4	6	7	7	5	4	2	1	1	2	3
UA9 = 18	4	7	5	5	4	4	4	2	2	3	4	3	3	4	6	6	5	4	2	1	1	1	2	2
UA0 = 19	3	3	4	5	6	7	7	7	7	8	8	8	8	7	7	8	8	7	6	4	3	2	1	2
4X = 20	6	6	6	6	5	5	4	3	2	1	1	1	1	2	2	5	2	1	1	1	-	1	3	5
HZ = 21	5	5	4	4	5	2	1	-	-	-	-	-	1	3	4	4	2	2	1	-	1	1	2	4
VU = 22	2	2	2	1	1	-	-	-	-	-	1	4	4	5	5	5	6	3	2	1	-	1	1	2
JT = 23	2	3	4	4	3	3	4	4	4	5	5	5	5	5	6	8	7	6	5	3	2	2	2	2
VR2 = 24	-	-	-	-	-	1	2	4	5	6	8	8	8	8	7	8	8	7	5	4	2	1	-	1
JA1 = 25	1	1	2	3	5	6	7	6	7	7	7	8	8	6	5	8	8	7	6	5	2	1	-	1
HS = 26	-	-	-	-	-	-	-	-	2	3	5	6	6	6	6	7	6	5	4	2	1	-	-	-
DU = 27	-	-	-	-	-	-	2	5	6	7	8	8	8	8	8	8	8	7	5	3	1	-	-	-
YB = 28	1*	-	-	-	-	-	-	-	3	5	7	8	8	8	7	7	6	5	3	1	-	-	-	-
VK6 = 29	-	-	-	-	-	-	-	1	4	6	7	8	8	8	8	7	6	2	1	-	-	-	-	-
VK3 = 30	-	-	-	-	-	2	4	7	8	8	8	9	9	8	8	7	6	3	1	-	-	-	-	-
KH6 = 31	7	8	9	9	9+	9+	9	8	7	7	8	9	9	7	5	9	9	9	8	6	3	2	2	3
KH8 = 32	-	1	3	6	8	8	9	9	9	9	9	9	9	8	8	7	7	5	2	-	-	-	-	-
CN = 33	6	7	8	8	8	7	5	7	7	6	3	1	1	1	1	-	-	-	1	1	1	1	2	6
SU = 34	7	6	6	6	6	5	5	3	2	1	1	-	1	2	1	6	1	2	1	-	-	1	3	5
6W = 35	7	8	8	8	8	8	8	8	8	7	5	2	1	-	-	-	-	-	-	-	-	1	4	6
D2 = 36	5	6	6	7	7	6	5	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3
5Z = 37	4	5	4	5	5	3	1	-	-	-	-	-	-	1*	2*	6	1*	1	1	-	-	-	1	2
ZS6 = 38	5	6	6	7	7	5	3	1	-	-	-	-	-	-	1*	1*	2*	-	-	-	-	-	-	2
FR = 39	5	3	2	1	1	-	-	-	-	-	-	-	-	2	2	2	3	1	-	-	-	-	1	1
FJL = 40	6	6	5	6	7	5	3	2	2	2	2	1	1	2	7	7	6	6	5	5	2	5	4	5
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

Expected signal levels using 1500 W and 6 dBi isotropic antennas.

Example of new 30-meter table

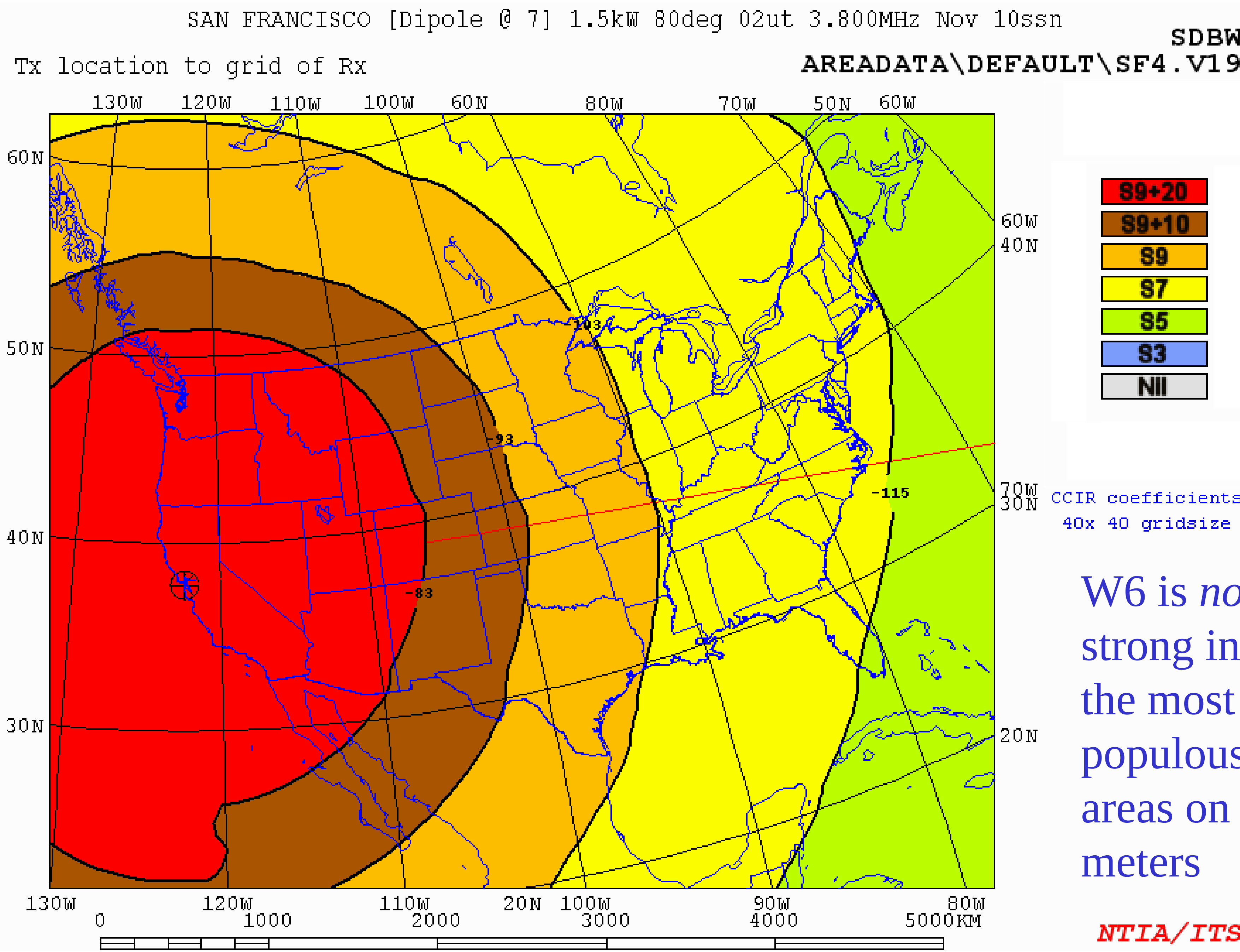
Visualization — Area Coverage Maps

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

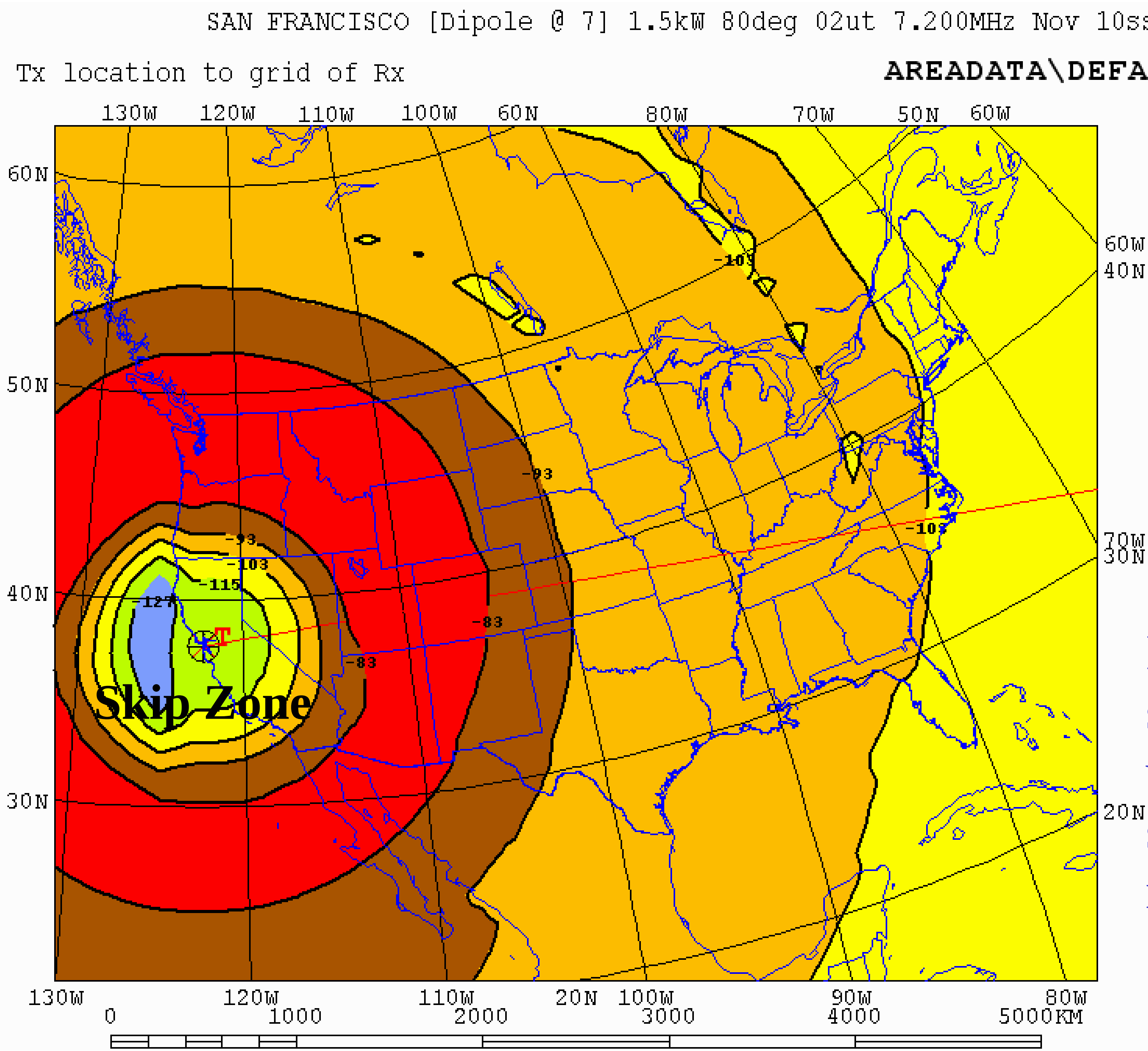
Visualization — Area Coverage Maps

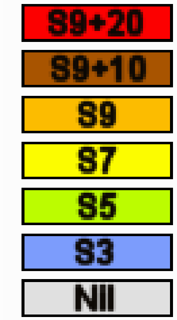
The following hand-made area-coverage maps are for San Francisco, CA, during a period of low solar activity in November (think ARRL Sweepstakes contest).

These maps were created using *VOAAREA*, part of the *VOACAP* (Voice of America Coverage Analysis Program) software suite.

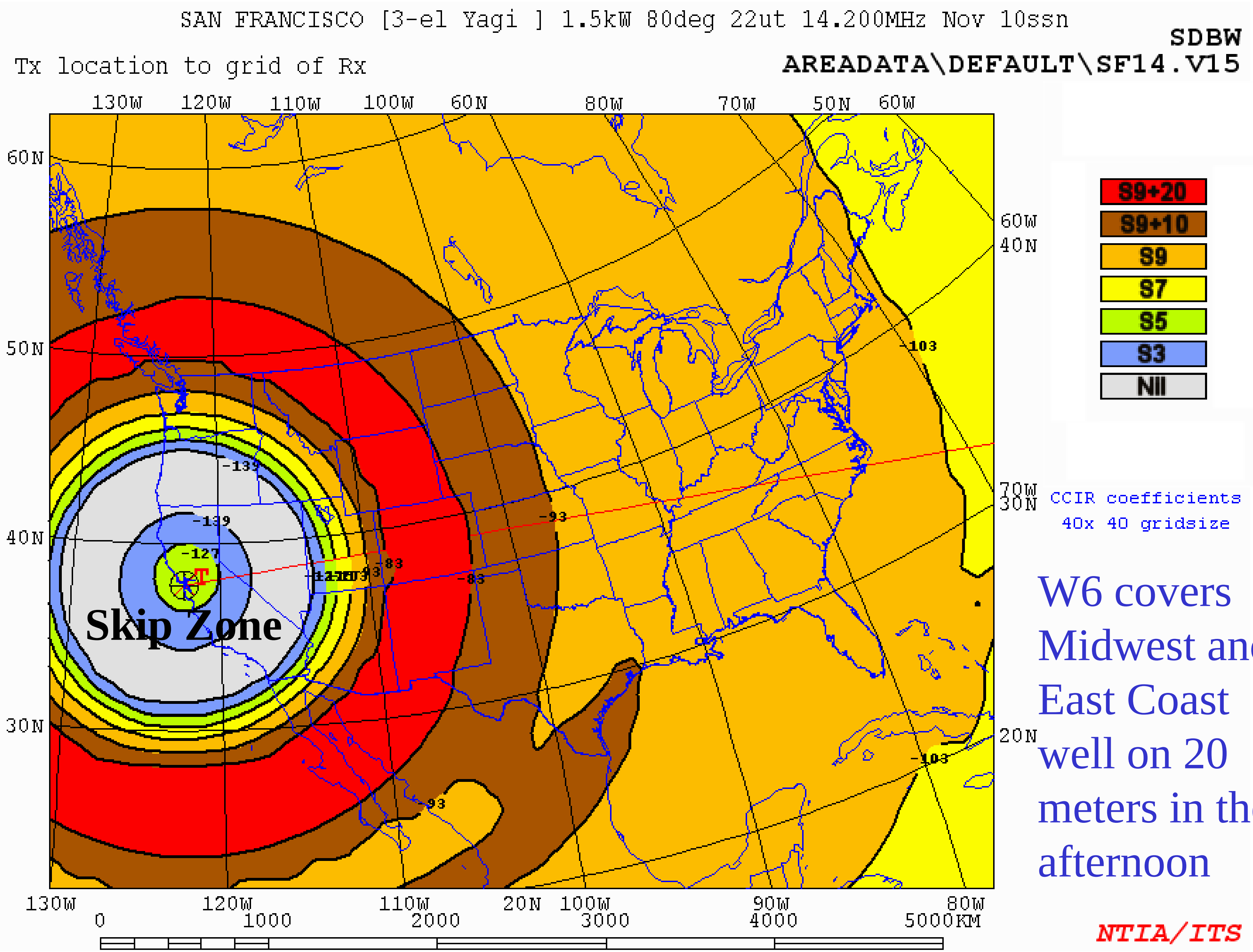


W6 is *not* strong in the most populous areas on 80 meters

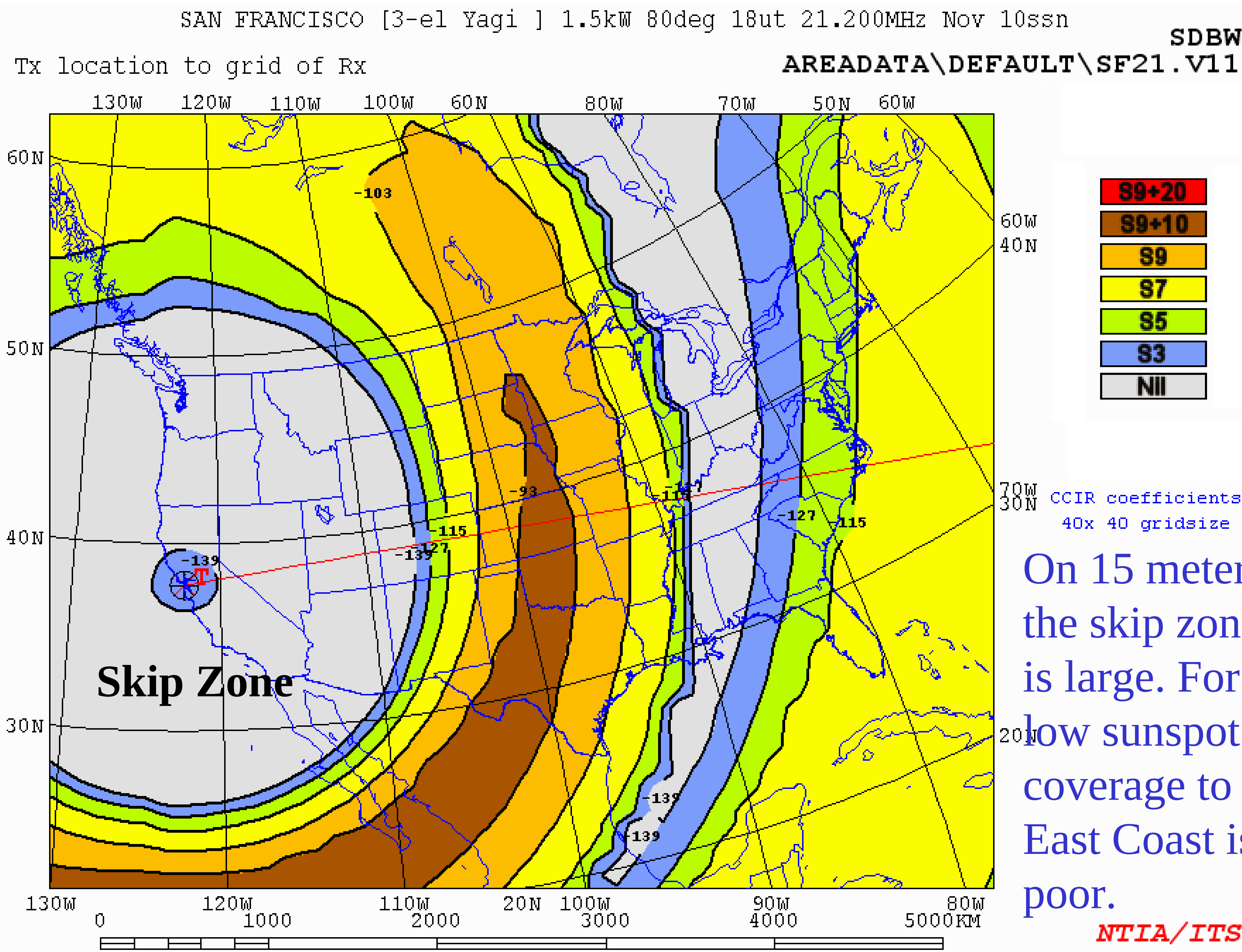




In So. Cal. signal is weak after sunset on 40 meters



W6 covers Midwest and East Coast well on 20 meters in the afternoon



On 15 meters, the skip zone is large. For low sunspots, coverage to East Coast is poor.

“Exotic” Propagation Modes

- The HF propagation predictions just described are for either “short path” or “long path.”

N6BV Propagation Predictions

10 Meters: Jan., CA (San Francisco), for SSN = High, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

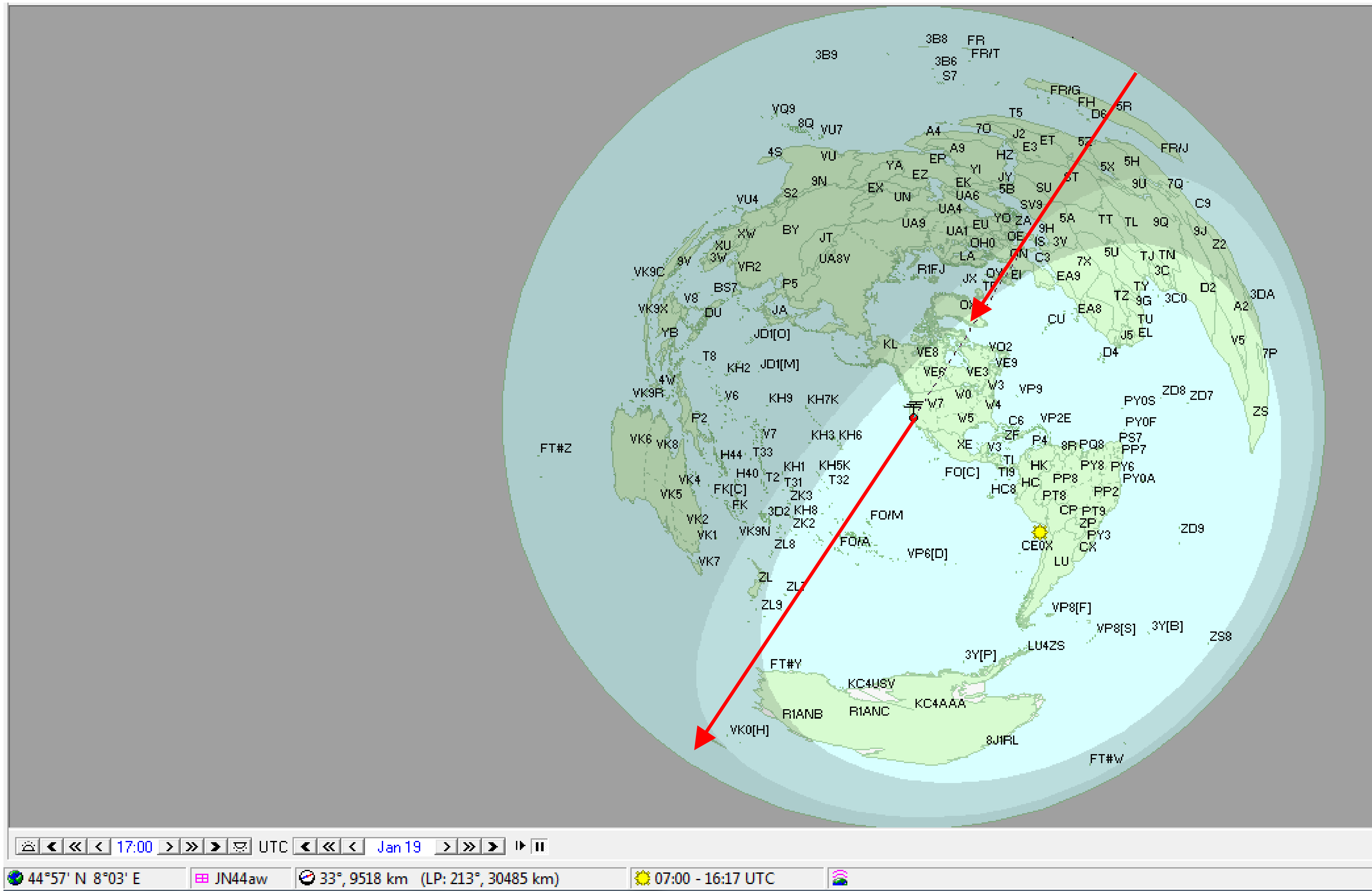
UTC -->

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	9+	7	2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	9+	9+	9+	9+
VO2 = 02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2*	5	9	8	6	1	-
W6 = 03	5	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	5	5	5	5	5	5
W9 = 04	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	9+	9+	9+	9+	9
W3 = 05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3*	3	3	2	-	-
XE1 = 06	9	4	3	-	-	-	-	-	-	-	-	-	-	-	-	3	9+	9+	9+	9+	9+	9+	9+	9+
TI = 07	5*	4*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	9	9	9	7	7	5
VP2 = 08	5*	6*	2*	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	9	9	9	9	9	5*
P4 = 09	5*	5*	1*	-	-	-	-	-	-	-	-	-	-	-	-	1	9	9	9	9	9	9	9	5*
HC = 10	6*	5*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	9	9	9	9	9	9	9	9
PY1 = 11	9	2	1	-	-	-	-	-	-	-	-	-	-	-	-	6	8	7	8	7	9	9	9	9
CE = 12	9	5	3	1	-	-	-	-	-	-	-	-	-	-	-	5	8	8	8	8	8	9	9	9
LU = 13	9	5	3	-	-	-	-	-	-	-	-	-	-	-	-	6	8	8	8	8	8	9	9	9
G = 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I = 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6*	4*	2*	1*	-	-	-
UA3 = 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UN = 17	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-	-	2*	-	-	-	-	-	-	-
UA9 = 18	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UA0 = 19	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
4X = 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1*	7*	4*	2*	2*	2*	-	-
HZ = 21	-	-	-	-	2*	-	-	-	-	-	-	-	-	-	-	-	5*	3*	1*	-	-	-	-	-
VU = 22	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-	-	5*	3*	2*	-	-	-	-	-
JT = 23	1	6	2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VR2 = 24	8	7	1	1	-	-	-	-	-	-	-	-	-	-	-	4*	-	-	-	-	-	-	-	-
JA1 = 25	6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
HS = 26	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	4*	6*	2*	1*	-	-	-	-	-
DU = 27	8	8	3	1	-	-	-	-	-	-	-	-	-	-	-	3*	1*	-	-	-	-	-	-	8
YB = 28	6	7	1	-	-	-	-	-	-	-	-	-	-	-	-	2*	1*	1*	-	-	-	-	-	-
VK6 = 29	-	1	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VK3 = 30	6	7	7	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	5
KH6 = 31	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	2	1	2
KH8 = 32	4	6	8	8	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5	9	7	1	1*	1
CN = 33	2*	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	4*	3*	2*	3*	4*	3*
SU = 34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1*	7*	3*	2*	1*	1*	-	-
6W = 35	3*	1*	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	9	8	4	3*	3*	4*
D2 = 36	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	9	5	6	8	8	9
5Z = 37	3	-	-	-	2*	-	-	-	-	-	-	-	-	-	-	-	-	5*	8	9	8	8	7	6
ZS6 = 38	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	8	8	7	7	7	6	5
FR = 39	-	-	-	-	3*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8	8	6	4	-
FJL = 40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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

Expected signal levels using 1500 W and 14 dBi isotropic antennas.

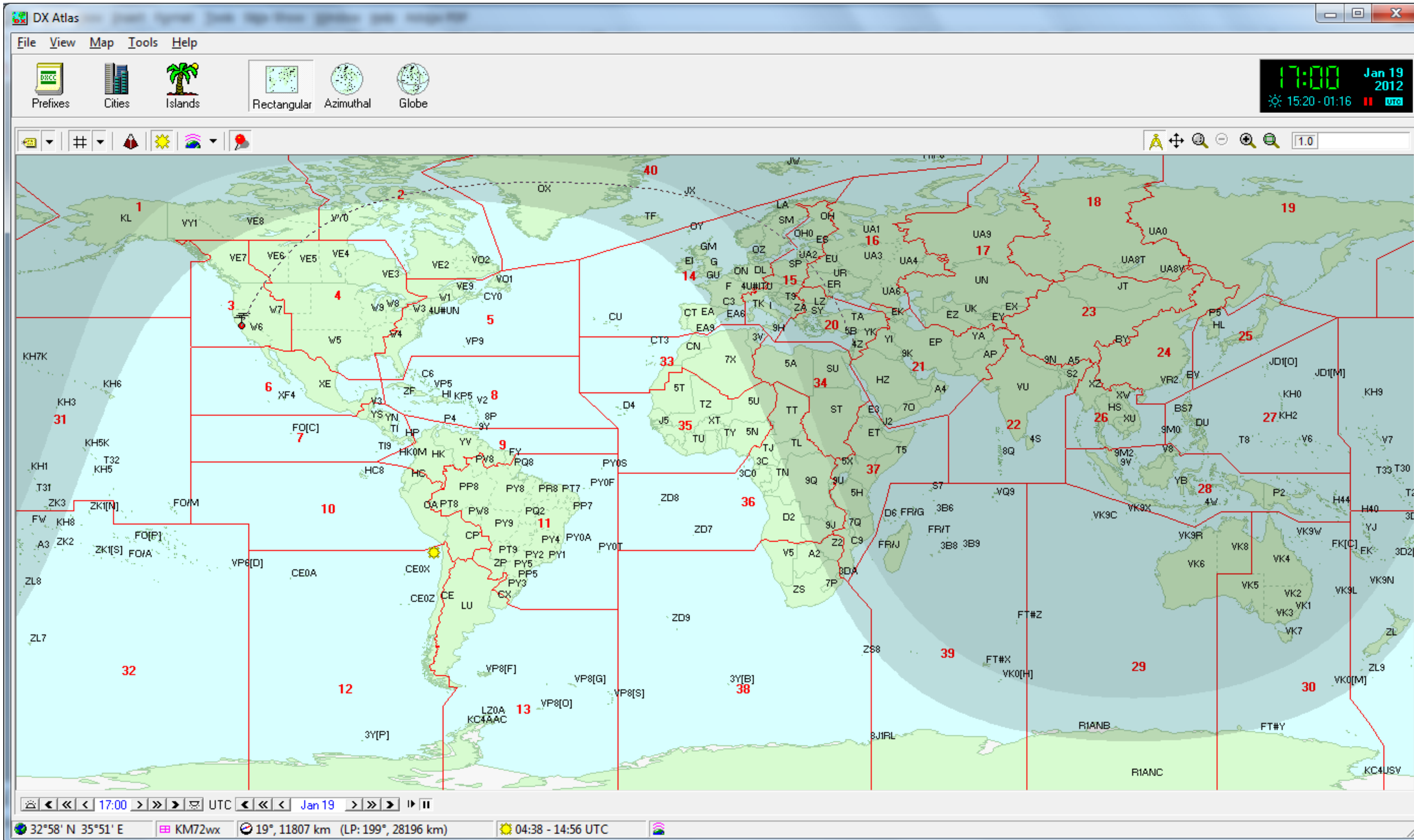
Long path to So. Europe/No. Africa on 10 meters.



33° short-path to Italy

213° long-path to Italy

DX Atlas with azimuthal projection



19° short-path to Israel

199° long-path to Israel

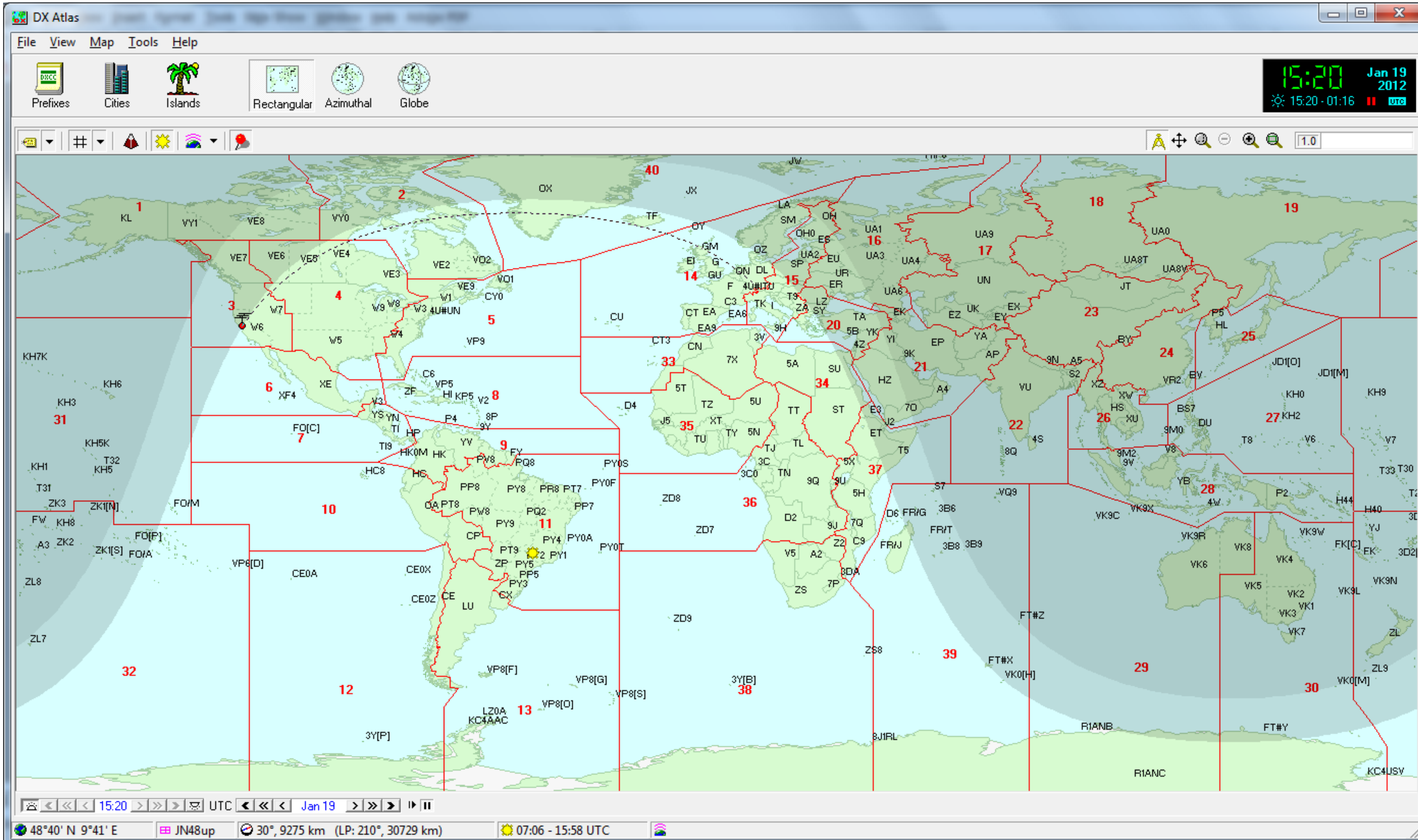
DX Atlas, with Mercator projection

“Exotic” Propagation Modes

- The HF propagation predictions just described are for either “short path” or “long path.”

Long-path openings on the lower bands can be very short — even only a minute long on 160! Thus, predictions good for a whole hour may easily miss such transient openings.

Grayline information, however, can be very useful on the lower bands.



30° short-path to Austria

210° long-path to Austria on 80 meters

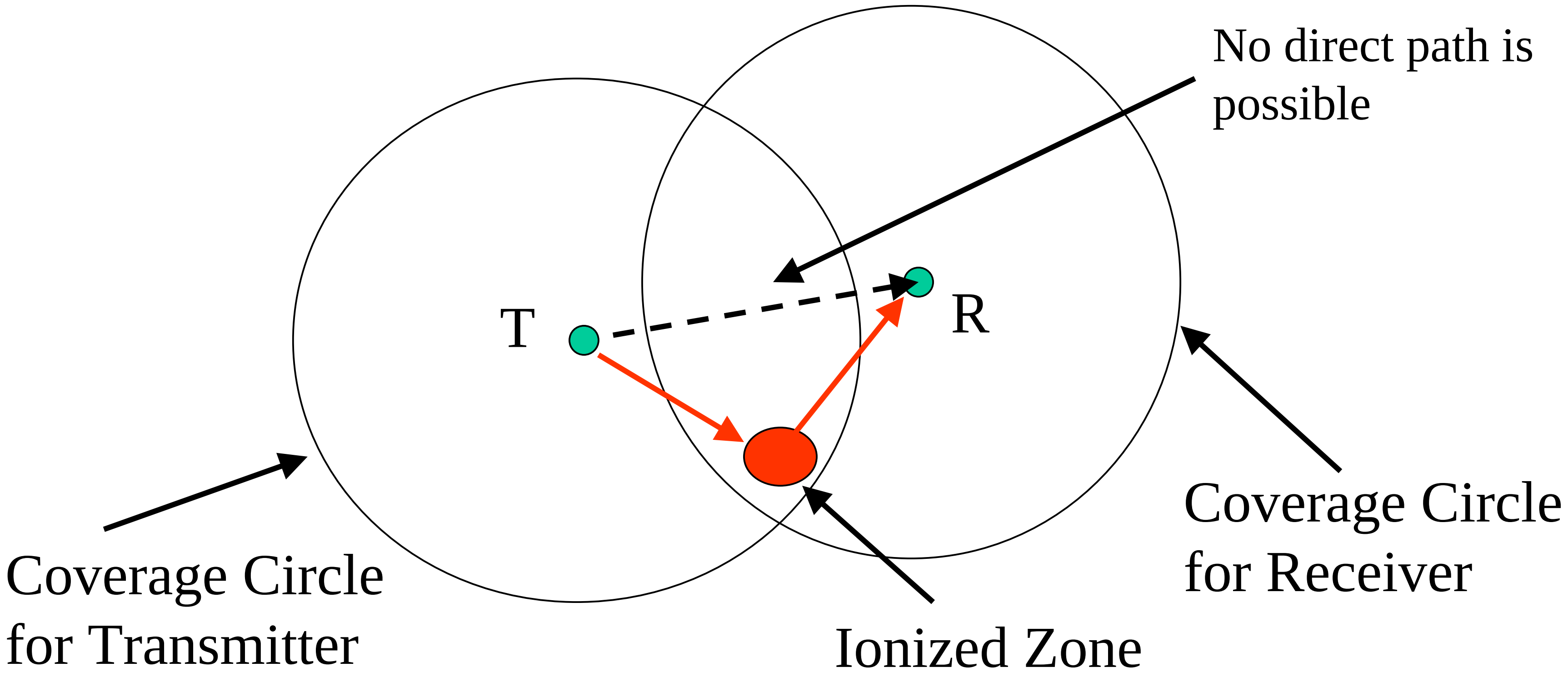
DX Atlas, with Mercator projection

“Exotic” Propagation Modes

• The HF propagation predictions just described are for either “short path” or “long path.”

• Sidescatter (skew) paths – especially when sunspots are low.

Sidescatter (Skew) Propagation



A common 15-meter skew-path opening is from W6 to Europe, with both stations pointing their beams at CT3. This occurs shortly before the morning direct short-path opening.

“Exotic” Propagation Modes

- The HF propagation predictions just described are for either “short path” or “long path.”
- Sidescatter (skew) paths – especially when sunspots are low.
- Backscatter paths – close-in stations.

Backscatter Paths

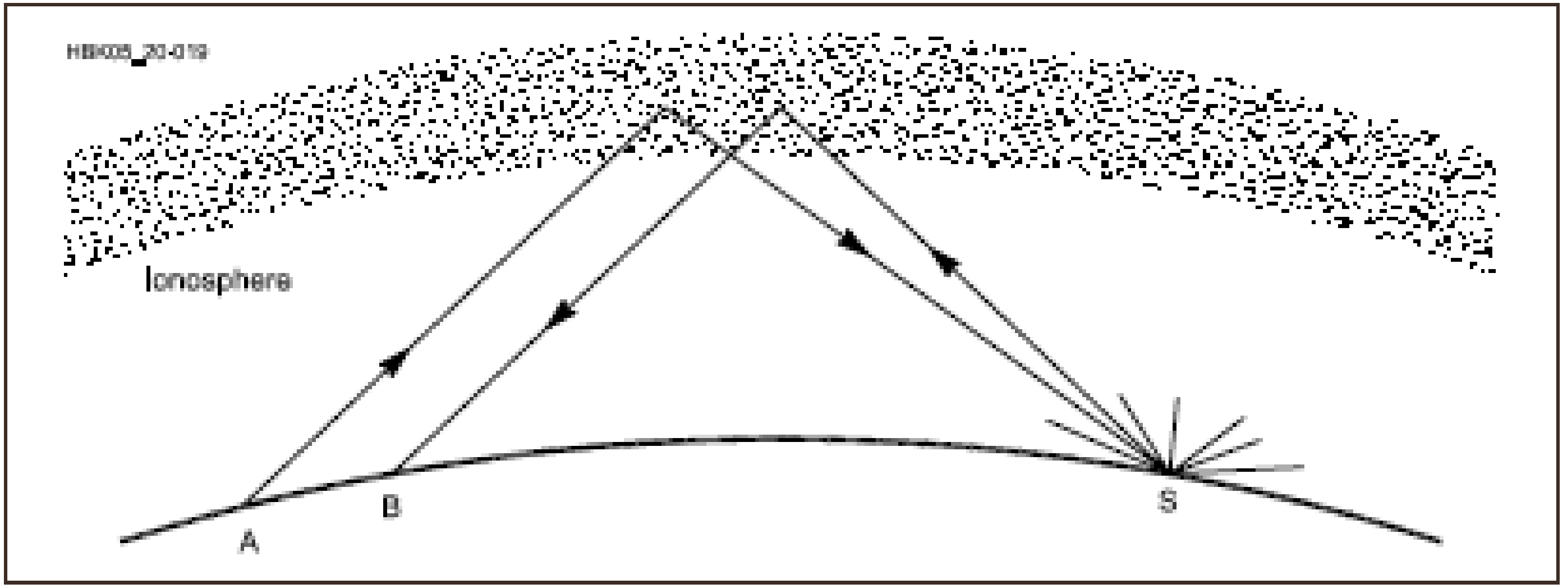


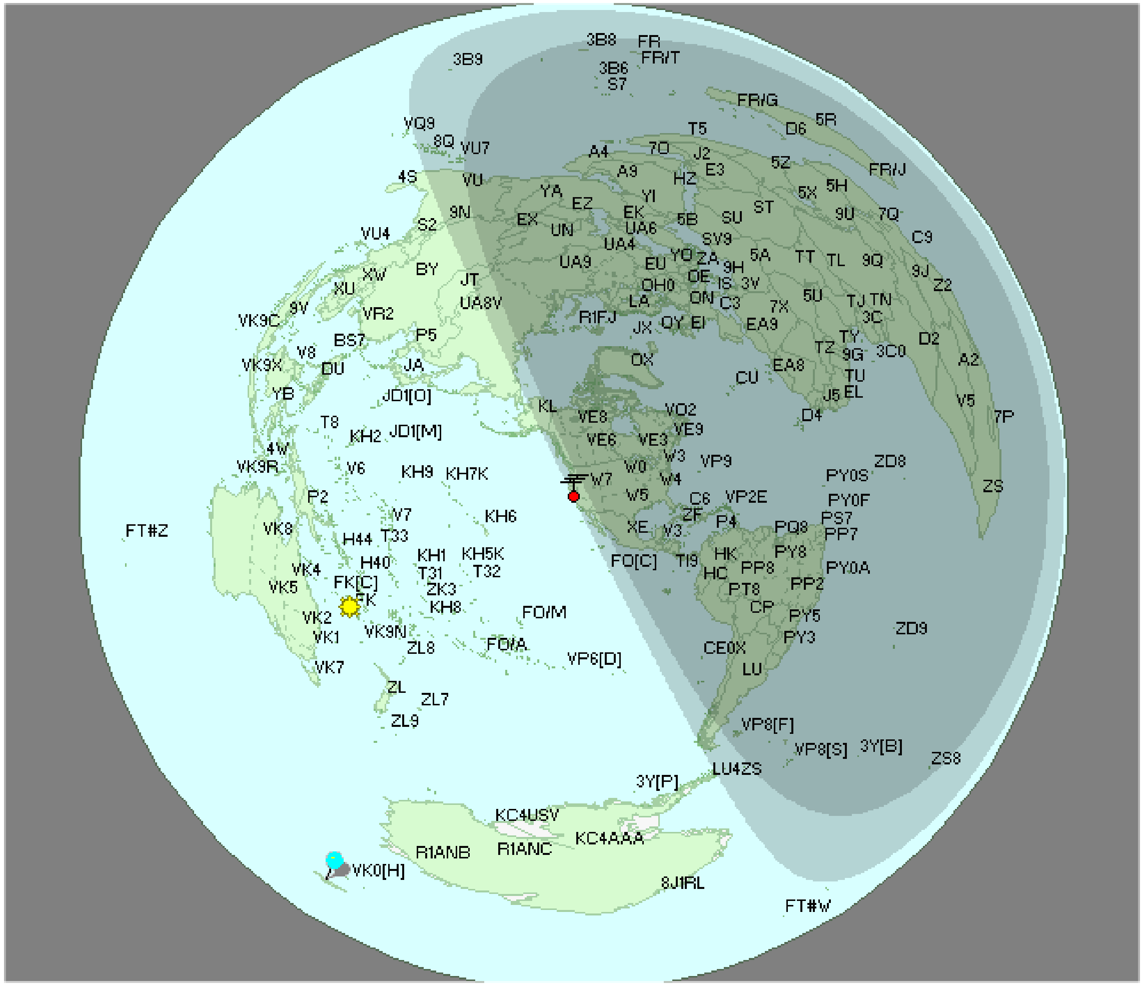
Fig 20.19—Schematic of a simple backscatter path. Stations A and B are too close to make contact via normal F-layer ionospheric refraction. Signals scattered back from a distant point on the Earth's surface (S), often the ocean, may be accessible to both and create a backscatter circuit.

This allows us to work locals on 15 or 10 meters in the SS.

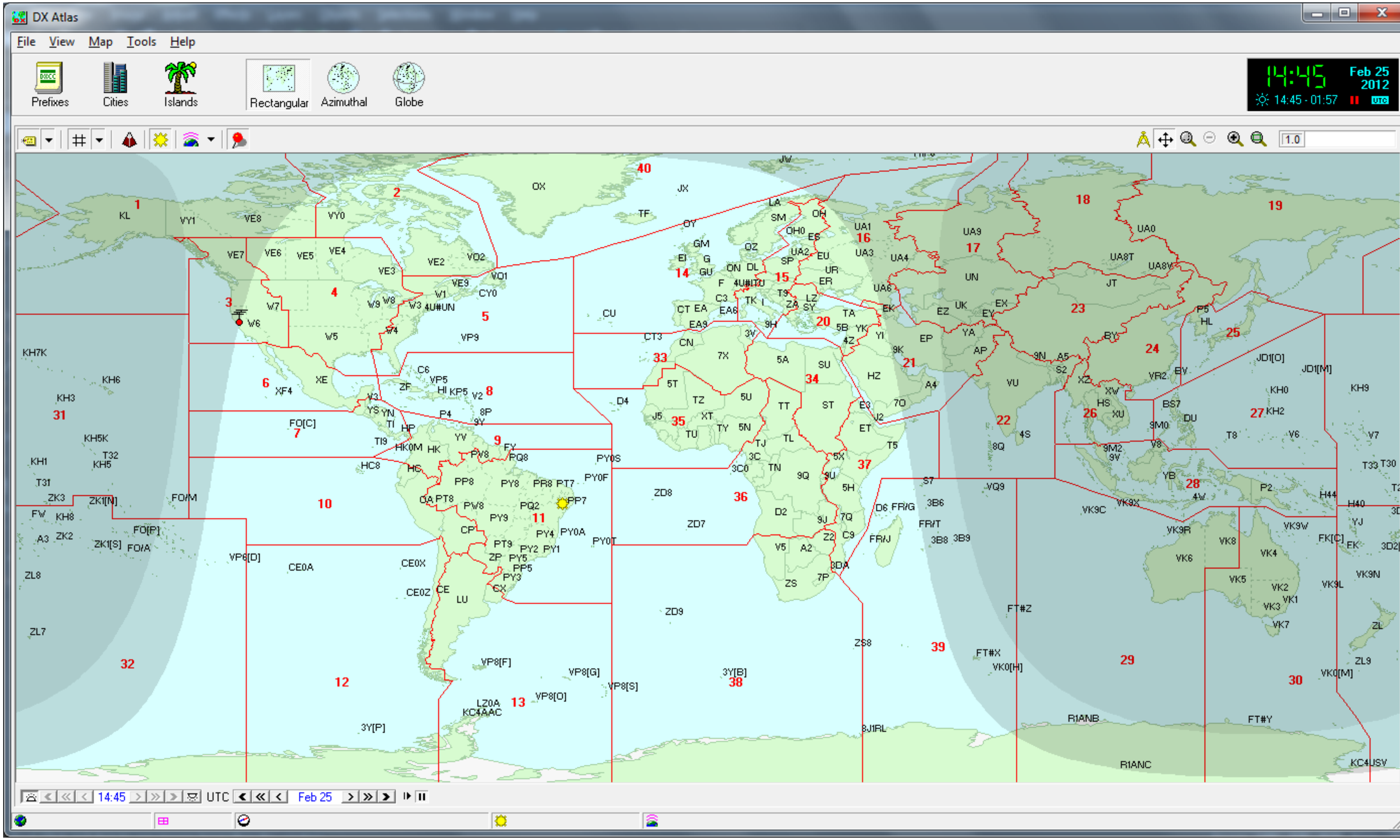
“Exotic” Propagation Modes

- The HF propagation predictions just described are for either “short path” or “long path.”
- Sidescatter (skew) paths – especially when sunspots are low.
- Backscatter paths – close-in stations.
- Grayline paths – along the sunset/sunrise “terminator” on the lower bands.

“Exotic” Propagation Modes



Grayline short-path propagation: W6 (sunset) to VU2 (sunrise), late November on 40 meters.



Morning 80-meter longpath along grayline to UA6 from N6RO in late February

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"Exotic" Propagation Modes

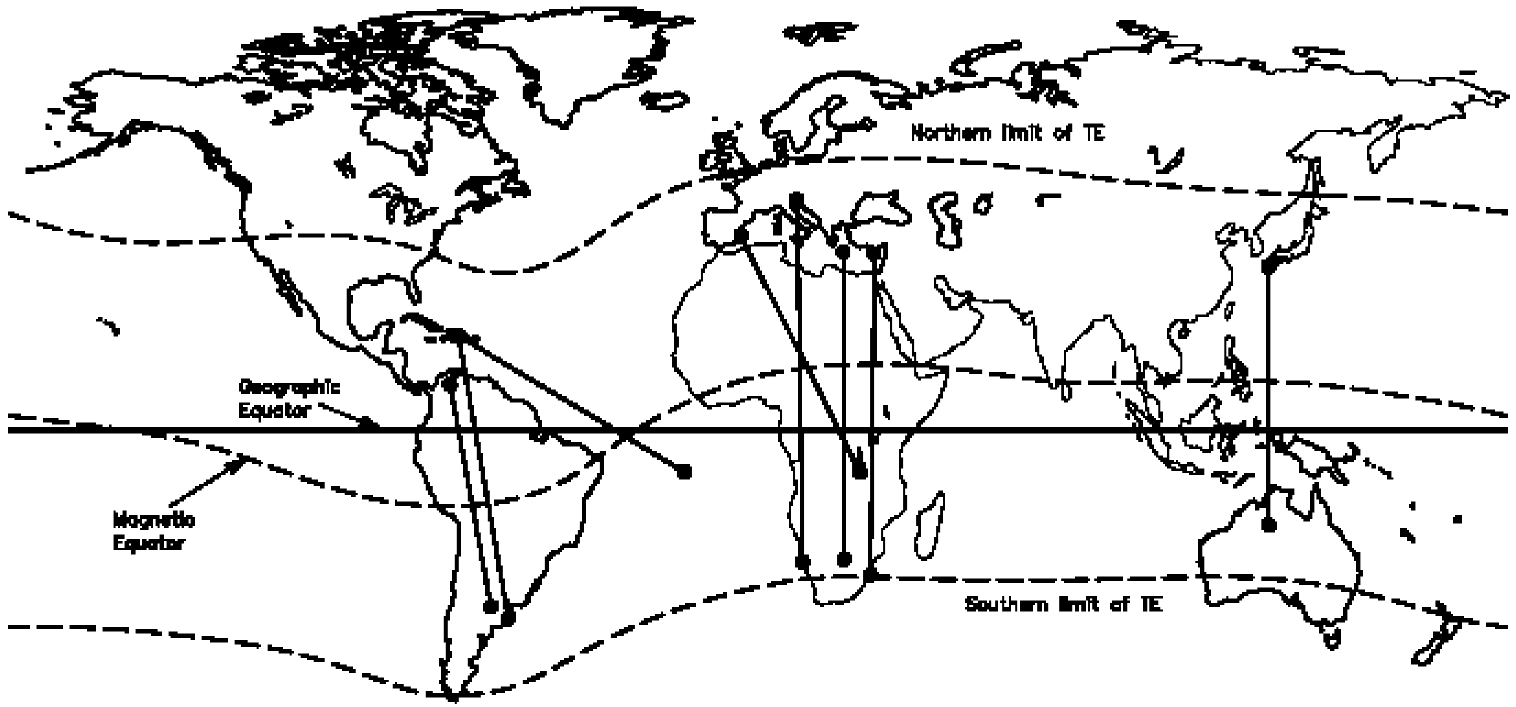

Fig 8—Transequatorial spread-F propagation takes place between stations equidistant across the geomagnetic equator. Distances up to 8000 km (5000 miles) are possible on 28 through 432 MHz. Note that the geomagnetic equator is considerably south of the geographic equator in the Western Hemisphere. (*Figure courtesy of The ARRL Handbook.*)

Transequatorial propagation on 10 meters.

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- Sporadic-E.

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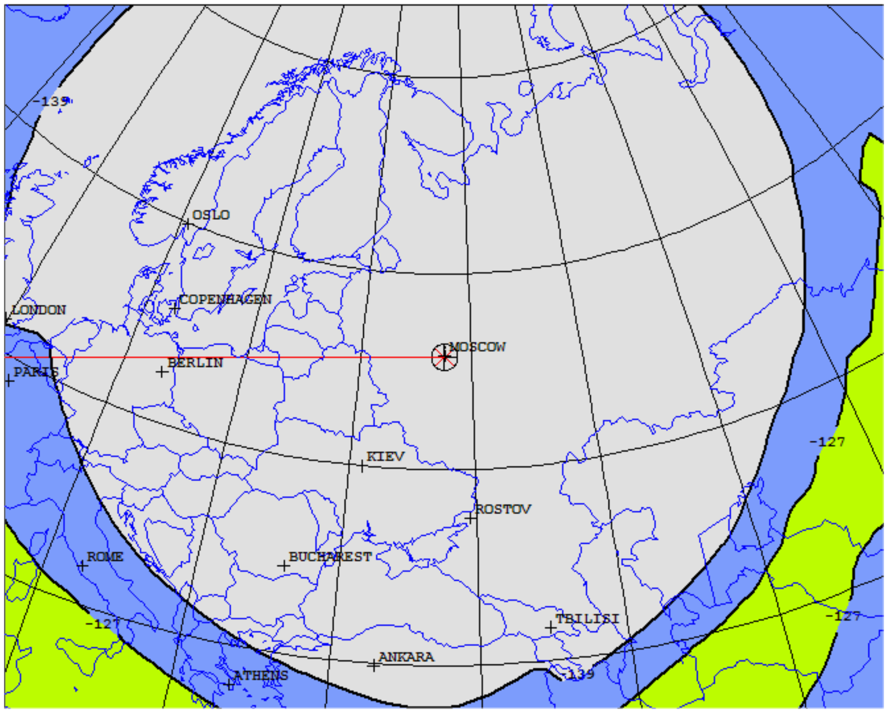
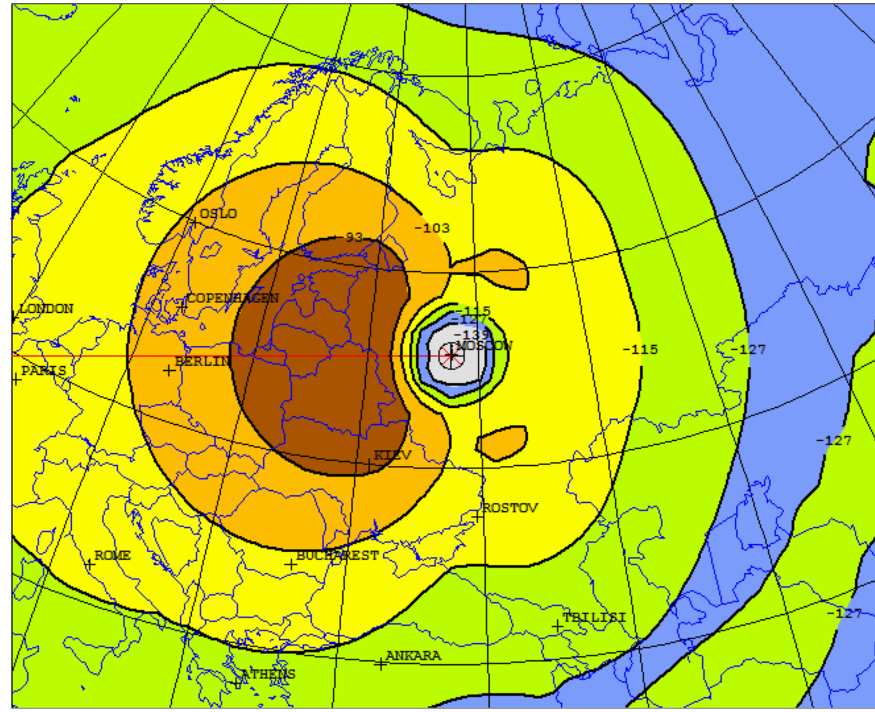
Side-by-Side Comparisons for Europe: July, 2010, 03 UTC (Sunrise, Zone 27), 20 Meters





Without Sporadic-E

With Sporadic-E

WRTC July 2010, Moscow

“Exotic” Propagation Modes

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- E_S most common in December and June.
- Sporadic-E “clouds” can be anywhere geographically.
- E_S signals can be exceptionally loud!

Summary

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Summary

• Ionospheric propagation of HF signals is *very* complicated.

• But that just makes it more interesting and challenging for an operator! (Where do I turn the beam — short-path, long-path, skew-path, grayline?)

• There are propagation-prediction programs that can help, but there's nothing like actually getting on the air and hearing what's coming in — before the big guns get there!

And Where Can You Get the N6BV Propagation Predictions?

- The exclusive distributor is *Radio-Ware* (also known as *Radio Bookstore*).

  http://www.radio-ware.com/

- The price is $30.

- Also see my webinar “Tactical Use of Propagation Predictions for HF Contesting” at:

  http://nccc.cc/webinars.html