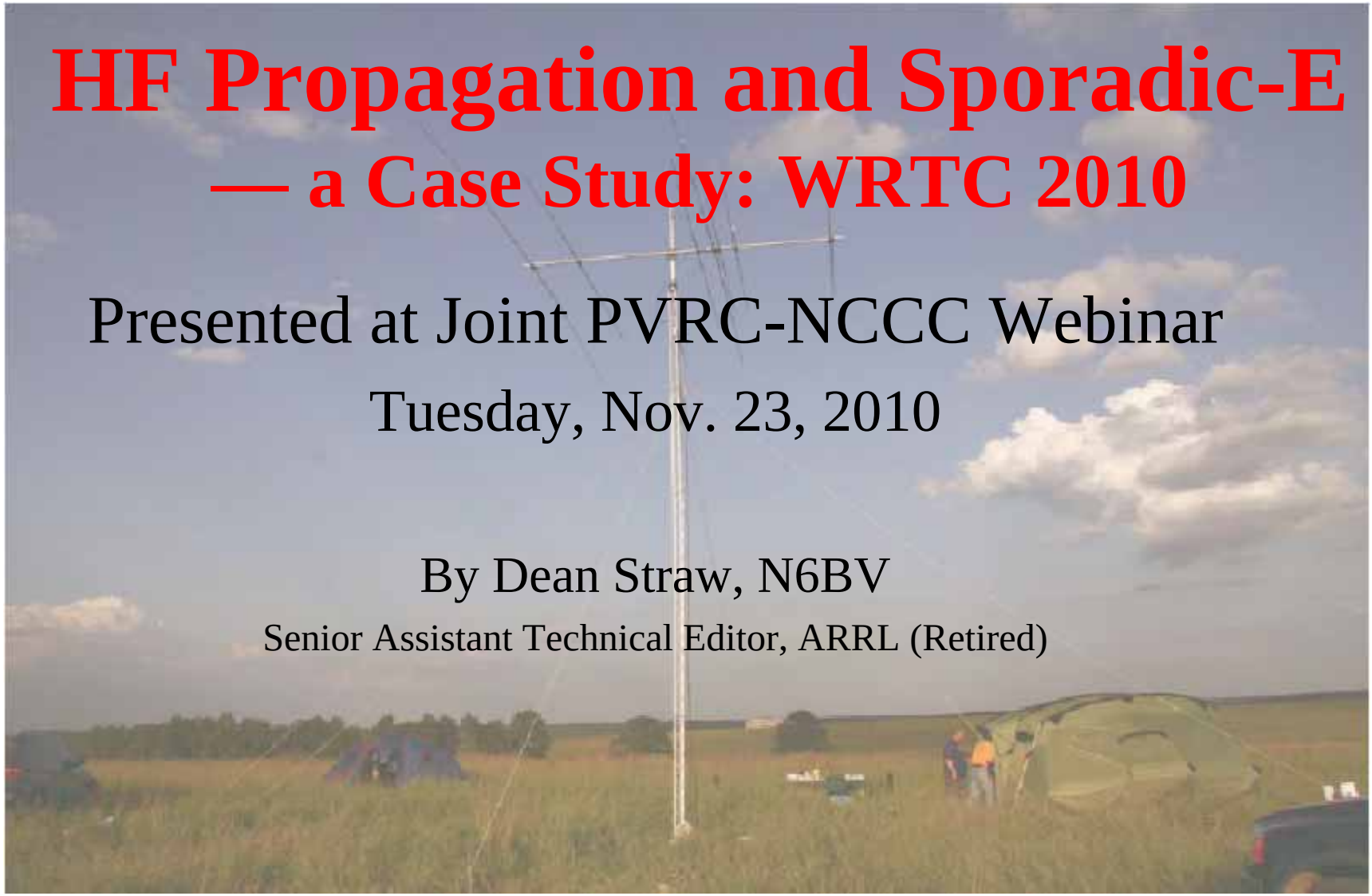


HF Propagation and Sporadic-E
— a Case Study: WRTC 2010

Presented at Joint PVRC-NCCC Webinar

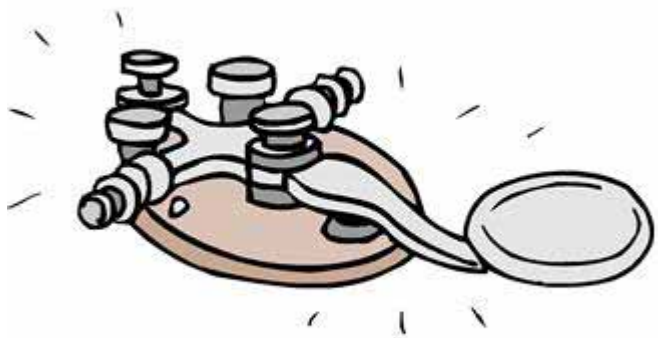
Tuesday, Nov. 23, 2010

By Dean Straw, N6BV

Senior Assistant Technical Editor, ARRL (Retired)

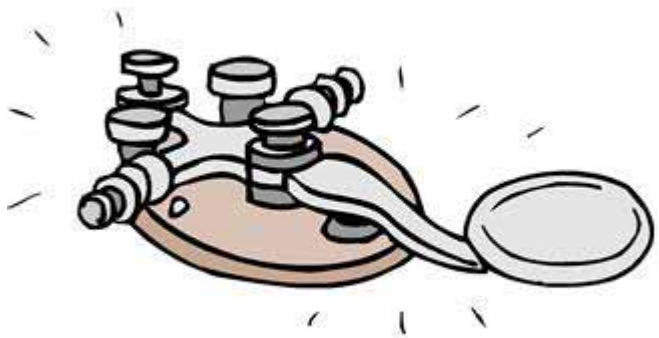
On May 24, 1844, Samuel Morse delivered the following message, the first ever sent by telegraph:

- “What hath God wrought?”



I’m going to suggest that during WRTC 2010, “What hath God wrought” was widespread Sporadic-E throughout Europe.

• And Sporadic-E made WRTC 2010 very exciting indeed! But there is a cautionary tale in this… the “back story” in this talk.



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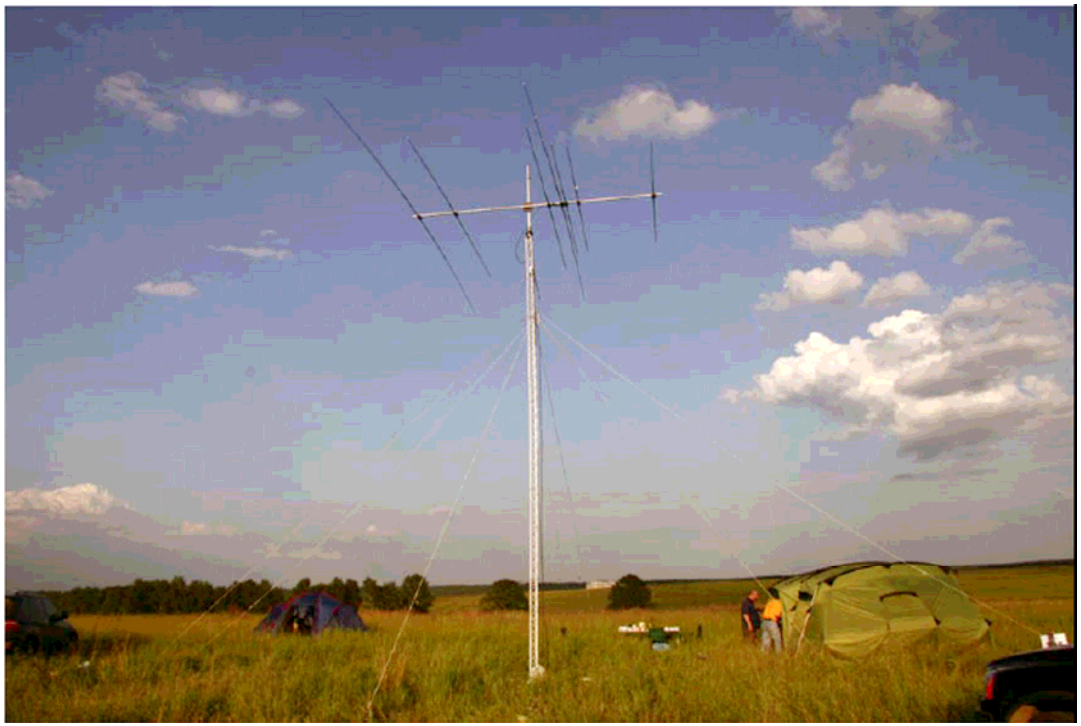
- It’s operated on 80, 40, 20, 15 and 10 meters, CW and SSB.

World Radiosport Team Championship

• Each team had 100 W and a tribander on a 30-foot tower and inverted-V dipoles on 40 and 80 meters. The terrain was flat.



Photo, courtesy EY8MM

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• There was one bright spot, however, and that is the topic of this presentation — Sporadic-E, aka E_s, or "short skip."

What is Sporadic-E?

• Leo F. McNamara, in his book *The Ionosphere: Communications, Surveillance, and Direction Finding* introduces "Sporadic-E" as:

> "As its name implies, sporadic E is a reflecting layer in the ionosphere which comes and goes sporadically at E-region heights. At mid-latitudes, sporadic E (E_s for short) layers are made up of clouds of electrons a few kilometers thick and a few hundred kilometers across, and occur at altitudes between approximately 90 and 130 km. To a radio wave, they often look like rather good quality mirrors."

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• And "good quality mirrors" produce *strong* signals! (N6BV).

N6BV Prediction Tables

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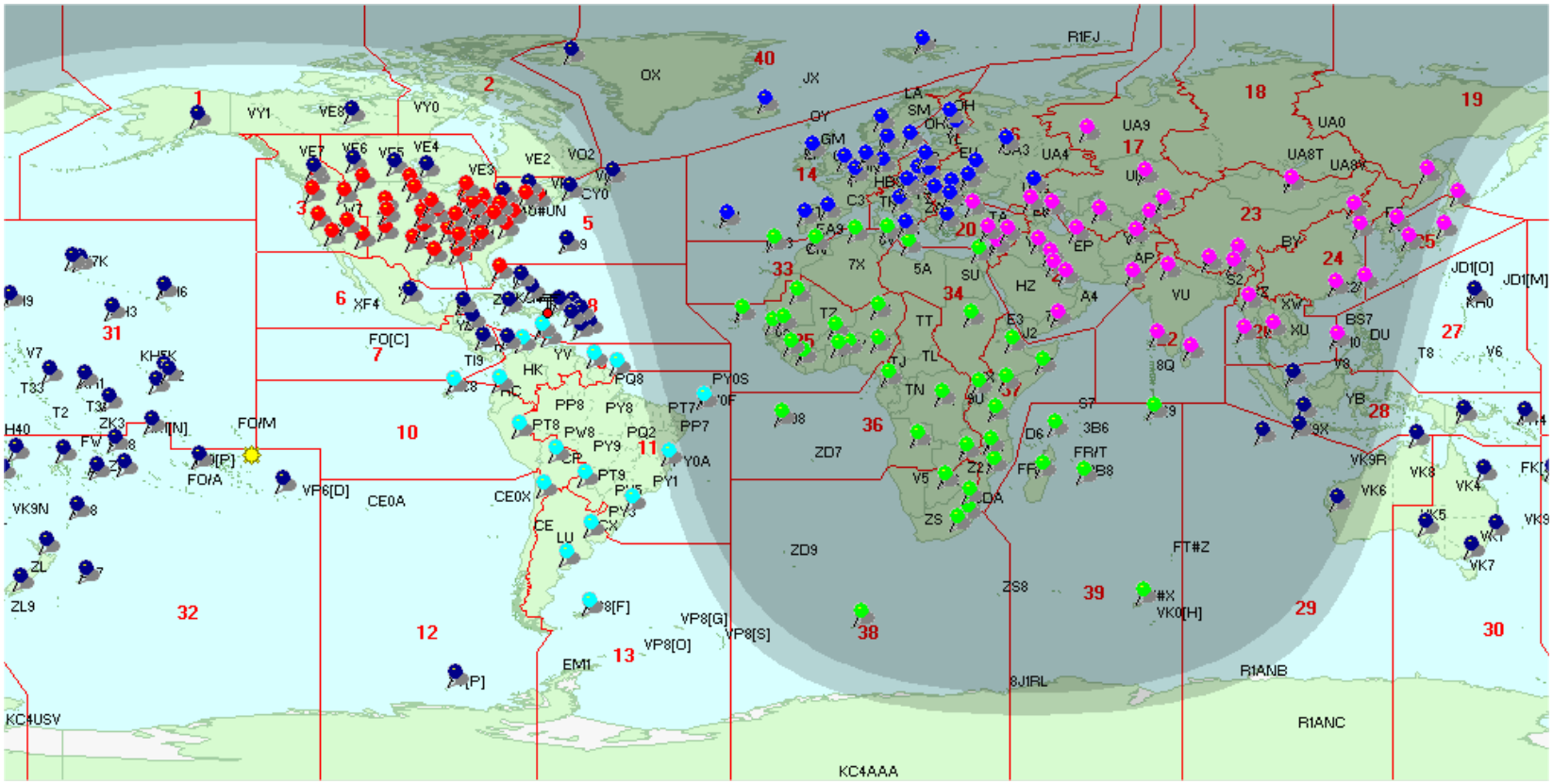

240+ transmitting QTHs around the world.
One just happens to be Moscow!

N6BV Prediction Tables

- *VOACAP* is the engine making the propagation predictions.
- The newest N6BV tables cover 240+ transmitting QTHs around the world.
- Each page in the Detailed Predictions shows one band over 24 hours, for 40 CQ Zones all around the world.

Detailed Prediction Table for 20 Meters

20 Meters: Jul., Eu. Russia (Moscow), for SSN = Low, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

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

Strong 20-meter signals into Moscow for “big gun” stations.

Detailed Prediction Table for 15 Meters

15 Meters: Jul., Eu. Russia (Moscow), for SSN = Low, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

	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	-	-	-	-	1*	5*	4*	2*	1*	1*	-	-	-	-	-	-	1*	3*	4*	3*	3*	1*	-	-
	VO2 = 02	-	-	-	-	-	-	-	-	-	-	-	-	-	1*	1*	-	-	1*	-	1*	-	-	-	-
USA	W6 = 03	-	-	-	1*	4*	5*	3*	2*	1*	1*	-	-	-	-	1*	4*	5*	5*	4*	2*	1*	-	-	-
USA	W9 = 04	-	-	-	2*	-	-	-	-	-	-	-	-	-	1*	2*	2*	2*	2*	1*	1*	-	-	-	-
USA	W3 = 05	-	-	-	1*	-	-	-	-	-	-	-	-	-	2*	1*	2*	1*	1*	1*	-	-	-	-	-
	IB1 = 06	-	-	-	2*	4*	-	-	-	-	-	-	-	-	-	3*	5*	4*	2*	1*	1*	-	-	-	-
	TI = 07	-	-	-	4*	1*	-	-	-	-	-	-	-	-	-	2*	4*	2*	1*	1*	1	2	2	-	-
	VP2 = 08	-	-	1*	-	-	-	-	-	-	-	-	-	-	1*	1*	1*	1*	1*	1*	1	2	1	-	-
	P4 = 09	-	-	-	-	-	-	-	-	-	-	-	1	1	1*	1*	2*	1*	1	1	3	4	3	-	-
	HC = 10	-	-	-	4*	1*	-	-	1	-	-	-	-	2	2*	1	2*	2*	1*	2	4	5	5	-	-
	PY1 = 11	-	-	-	-	-	-	-	-	-	1	7	7	6	5	4	4	5	6	8	9	9	8	4	-
	CE = 12	-	-	-	-	-	2	1	-	-	-	-	-	3	1	1*	3*	4*	1	4	7	8	6	1	-
	LU = 13	-	-	-	-	2	1	-	-	-	-	-	5	2	-	2*	3*	1*	1	6	7	8	6	2	-
EU	G = 14	-	-	-	-	-	-	-	-	-	1*	-	-	-	-	-	1*	1*	2*	1	2	1	-	-	-
EU	I = 15	-	-	-	-	-	-	-	1	1	2	2	1	-	-	-	-	-	1	5	6	5	1	-	-
EU	UA3 = 16	8	8	8	8	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	8	8	8
EU	UN = 17	-	-	-	5	8	9	9	9	9	8	6	5	4	5	6	8	8	8	8	5	-	-	-	-
EU	UA9 = 18	-	-	-	-	1	2	4	6	6	5	3	3	3	5	5	5	5	3	4	1	-	-	-	-
EU	UA0 = 19	-	-	-	-	-	-	1*	2*	2*	2*	2*	1*	1*	-	-	-	-	-	-	-	-	2*	1*	-
EU	4X = 20	-	-	-	1	2	8	8	8	8	8	8	8	4	2	4	5	8	9	9	9	8	2	-	-
EU	HZ = 21	-	-	1	5	9+	9+	9+	9+	9+	9+	9+	9	9	9	9	9	9+	9+	9+	9	8	4	-	1
EU	YU = 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EU	JT = 23	-	-	-	-	-	-	-	-	1*	1*	1*	1*	1*	1*	1*	1*	1*	-	-	-	-	-	1*	-
JA	VR2 = 24	-	-	1	3	5	5	5	6	5	5	3	2	2	3	4	5	5	4	2	-	-	-	-	-
JA	JA1 = 25	-	-	-	-	-	1	5	4	4	2	2	1	1	2	1	2	2	-	-	-	-	2*	1*	-
	HS = 26	-	-	1	5	8	8	8	8	8	6	5	3	3	4	5	6	6	4	3	1	-	-	-	-
	DU = 27	-	-	-	-	1	1	1	2	2	1	1*	1*	1*	-	-	2	2	1	-	-	-	-	-	-
	YB = 28	-	-	1	5	8	7	7	7	8	8	5	4	3	4	5	7	4	-	-	-	-	-	-	-
	VK6 = 29	-	-	1	5	7	6	6	6	6	7	5	5	1	-	-	-	-	-	-	-	-	-	-	-
	VK3 = 30	-	-	1	4	5	5	5	7	7	5	2	-	-	-	-	-	-	-	-	1	-	-	-	-
	KH6 = 31	-	-	-	-	-	4*	5*	3*	2*	2*	1*	1	-	-	-	-	-	1*	5*	5*	2*	1*	-	-
	KH8 = 32	-	-	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6*	5*	-	-
	CN = 33	-	-	-	-	-	-	-	2	3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
	SU = 34	-	-	-	1	3	9	9	9	9	9	9	9	7	6	6	8	9	9	9+	9	9	5	-	-
	6W = 35	-	-	-	-	-	-	-	-	7	5	1	2	1	-	-	-	-	1	6	9	8	3	-	-
	D2 = 36	-	-	-	-	-	-	2	7	7	8	8	8	8	8	8	9	9	9	9	9	8	5	1	-
	5Z = 37	-	-	-	-	-	6	5	3	3	5	8	8	6	5	6	6	8	8	7	-	-	-	-	-
	ZS6 = 38	-	-	-	-	-	-	7	5	5	6	7	7	7	7	7	8	8	9	8	1	-	-	-	-
	FR = 39	-	-	-	-	6	8	7	6	6	7	7	7	7	6	7	7	8	8	8	6	2	-	-	1
	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 -->

UTC --> * = Longpath

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

Pretty grim F_2 predictions to USA, Europe and Japan.

Solar Activity in Prediction Tables

- Six levels of 12-month SSN (Smoothed Sunspot Number) or SF (Solar Flux):
  - VL = Very Low (SSN: 0 to 20)
  - LO = Low (SSN: 21 to 40) ← Where we're at now
  - ME = Medium (SSN: 41 to 60)
  - HI = High (SSN: 61 to 100)
  - VH = Very High (SSN: 101 to 150)
  - UH = Ultra High (SSN≥151)

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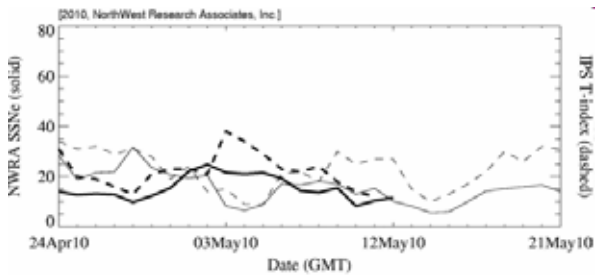
- Equivalent smoothed sunspot number:
  http://www.nwra.com/spawx/ssne.html



Details, N6BV Prediction Tables

• The antennas used in *VOACAP* to predict signal levels are isotropics, with gain. They emulate the antennas used in older tables (100' dipoles for 80/40; 3L20 at 100'; 4L15, 4L10 at 60').

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• Gain antennas are assumed to be optimally oriented to/from each QTH.

Details, N6BV Prediction Tables

• *VOACAP* predictions, however, normally don't invoke Sporadic-E modes, simply because they are so sporadic.

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• *VOACAP* predictions, however, normally don't invoke Sporadic-E modes, simply because they are so sporadic.

• Considering them can become very useful when planning for a contest where short-skip Sporadic-E might play an important role. More on this later!

N6BV Prediction Tables

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• They ask, “What about us little guns with 100 W and a dipole up 30 feet?”

• Well, if I had tailored the predictions specifically for the little gun, many of the weaker signals shown in the tables would simply disappear.

• And with nothing showing, you wouldn’t have *any idea* that propagation is even possible.

Recalibrating for Little-Gun Stations

1. **20 meters, high dipole vs high Yagi**: Subtract 2 S-units for 100' high dipole instead of 3L20 Yagi at 100'.

(Assumes one S-unit ≈ 4 to 5 dB, S9 = 50 μV)

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6. These are for both ends of a circuit, RX and TX.

Recalibrating for All Stations

- N0AX, poet laureate of ham radio, suggests subtracting 100 S-units if you keep calling and calling in pileups without ever listening…

Example: 20 Meters, Moscow to W6

20 Meters: Jul., Eu. Russia (Moscow), for SSN = Low, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

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

20 meters from Moscow to Zone 3 in July 2010 at 15 UTC.

Example: 20 Meters, UA3 to Zone 3

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• And a little gun in W6 will hear a WRTC station at about S1…

Resulting Predictions for WRTC Stations

20 Meters: Jul., Eu. Russia (Moscow), for SSN = Low, Sigs in S-Units. (c) 2010 Dean Straw, N6BV

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

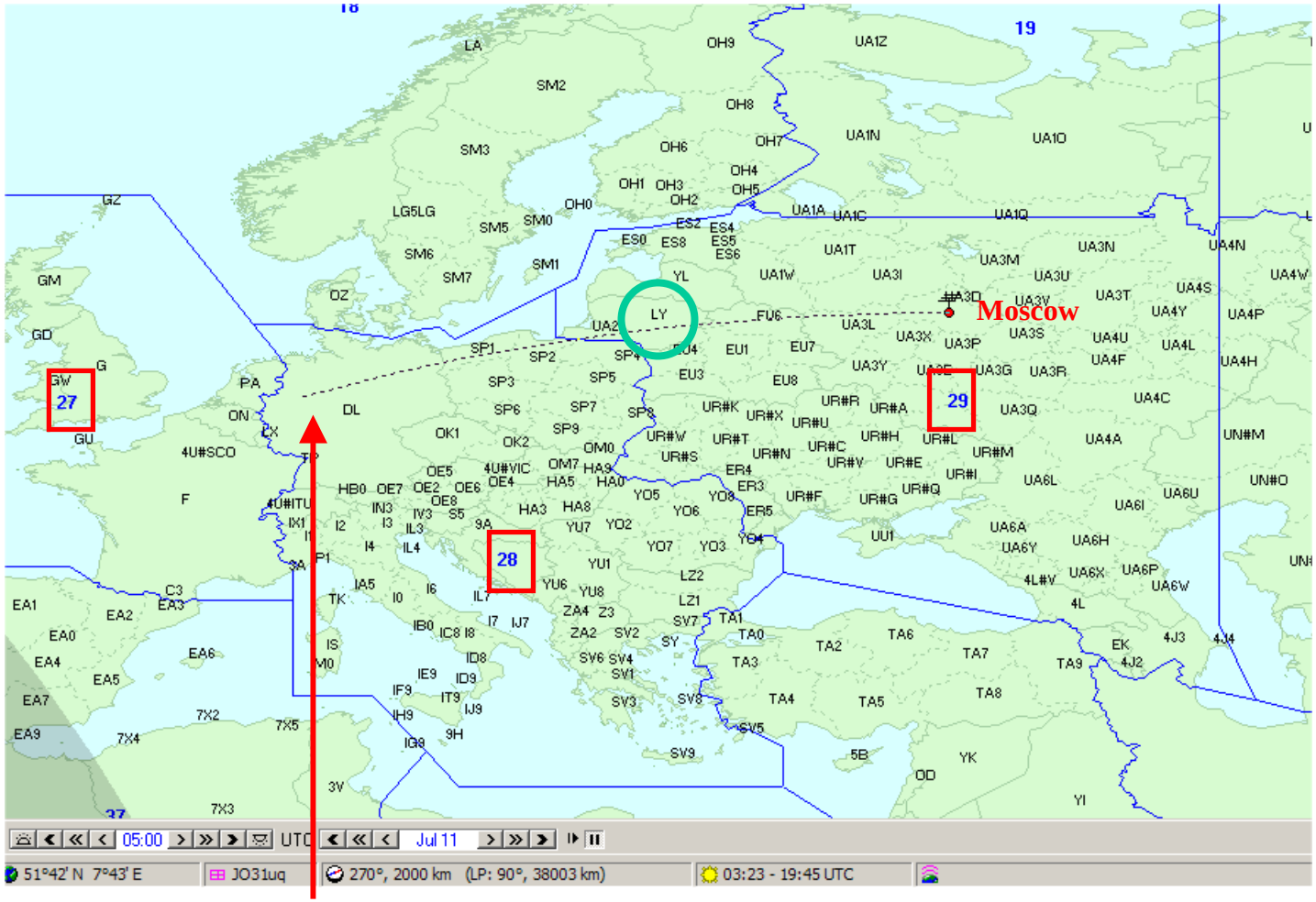
Expected signal levels using 100 W and WRTC antennas.

(*WRTC computations courtesy, Bob Wilson, N6TV*)

Note predictions for moderate-strength signals into Europe. Pileup management would be difficult.

So, what actually happened in WRTC 2010?

Large Target Population for WRTC is Eastern Europe, ITU Zones 28 & 29



2,000 km maximum single-E_s hop covers Zones 28 & 29. To DL, an E_s cloud would be at mid-point of path, over LY.

From R33M (N6MJ & KL9A) WRTC Log

R33M QSOs	All Zones	Zone 28	Zone 29
80 meters	496	90	272
40 meters	798	241	283
20 meters	1,537	465	290
15 meters	598	263	118
10 meters	174	24	86
Total	3,603	1,083	1,049

• Third place R33M (N6MJ and KL9A) made 59% of their QSOs in Zones 28 and 29 on all bands.

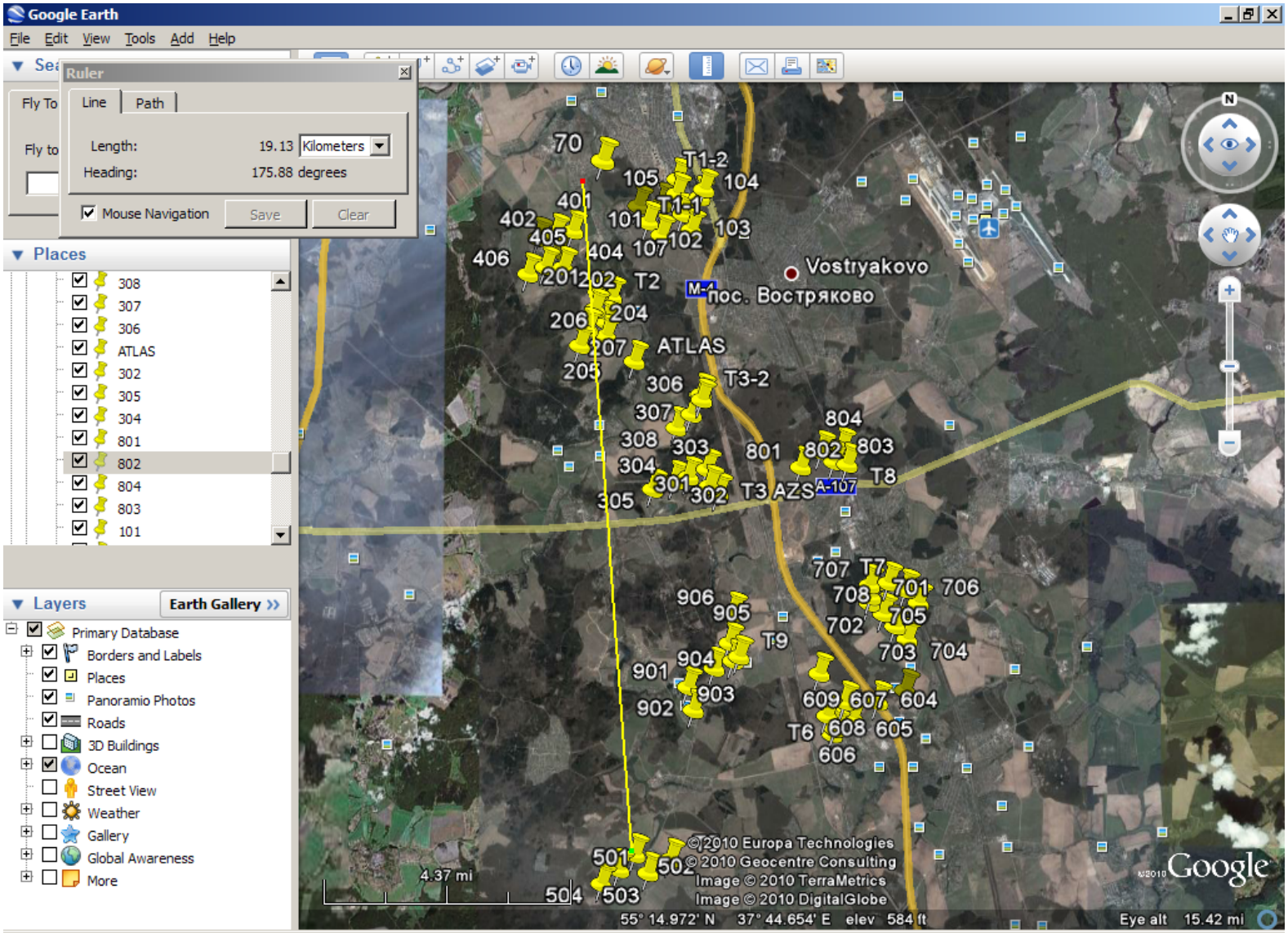
(Log, courtesy N6MJ & KL9A)

How Important was "Short Skip" E_s on 20-10 Meters in WRTC 2010?

R33M QSOs	All Zones	Zone 28	Zone 29 – Gnd Wave
20 meters	1,537	465	290 - 65 = 225
15 meters	598	263	118 - 54 = 64
10 meters	174	24	86 - 47 = 39
Total, 20 - 10 m	2,309	752	328

• R33M made 1,080 (47%) of their non-ground-wave QSOs in Zones 28 and 29 on 20/15/10 meters. This strongly suggests that short-skip E_s was present on the higher bands!

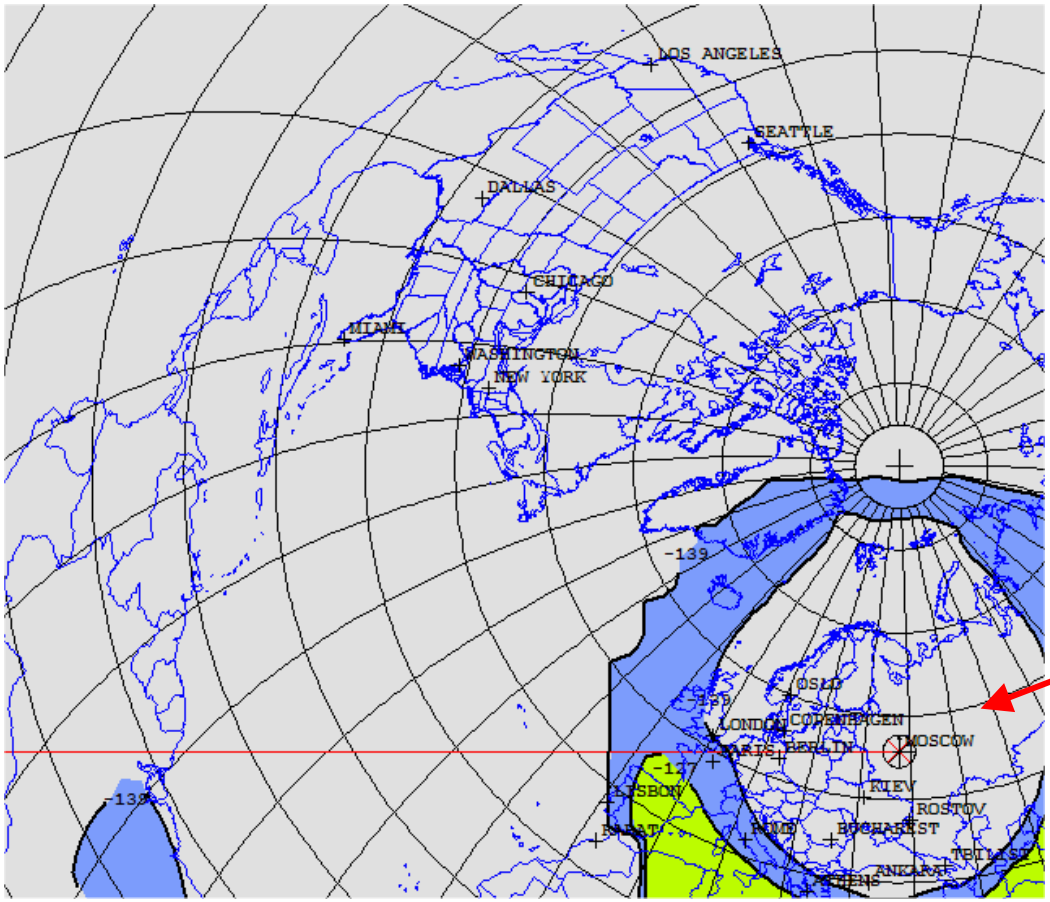
(QSOs between R33M and other WRTC R3 stations are assumed to be by ground wave and are subtracted from Zone 29 totals for this table.)



WRTC stations. Ground-wave, anyone?

F_2-Layer Propagation from Moscow

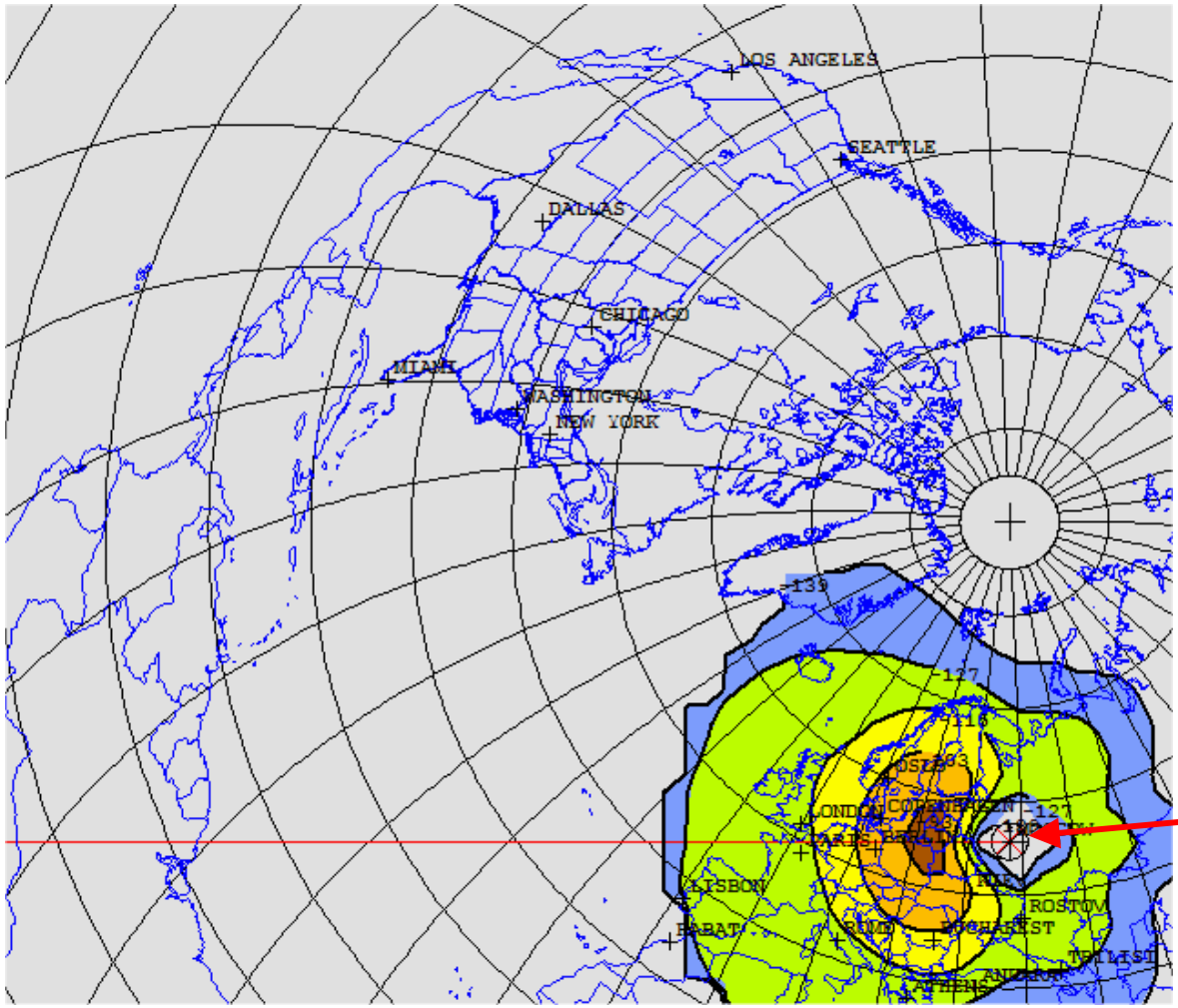
• *VOAAREA* F_2 prediction on 20 meters is grim in July at low sunspot levels (with no Sporadic-E), at 03 UTC, 100 W.



Skip Zone covers much of Europe

Generated using *VOAAREA*, beaming Europe.

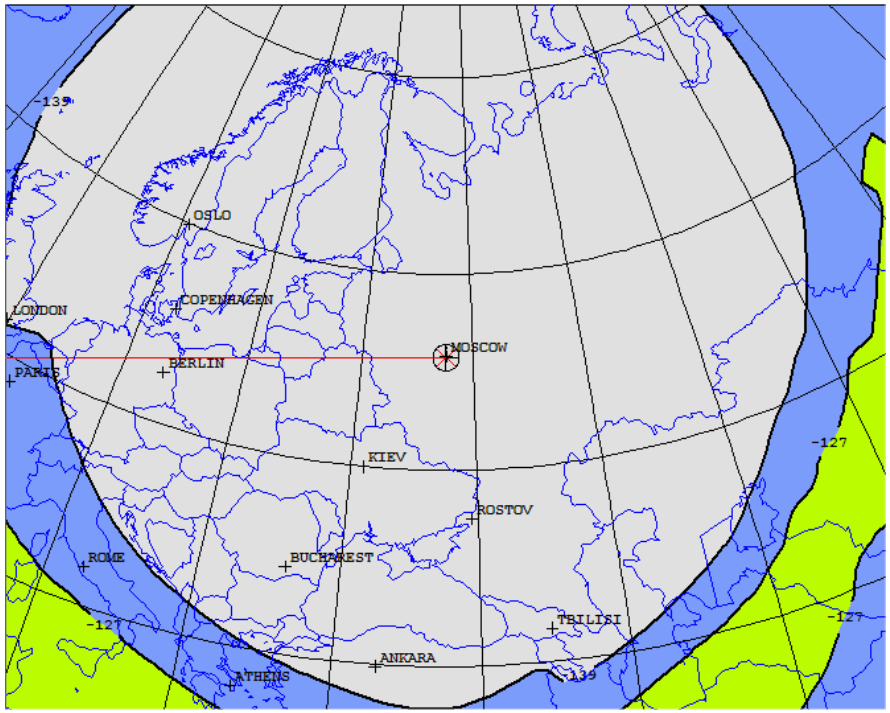
July on 20 meters in Moscow, with Sporadic-E

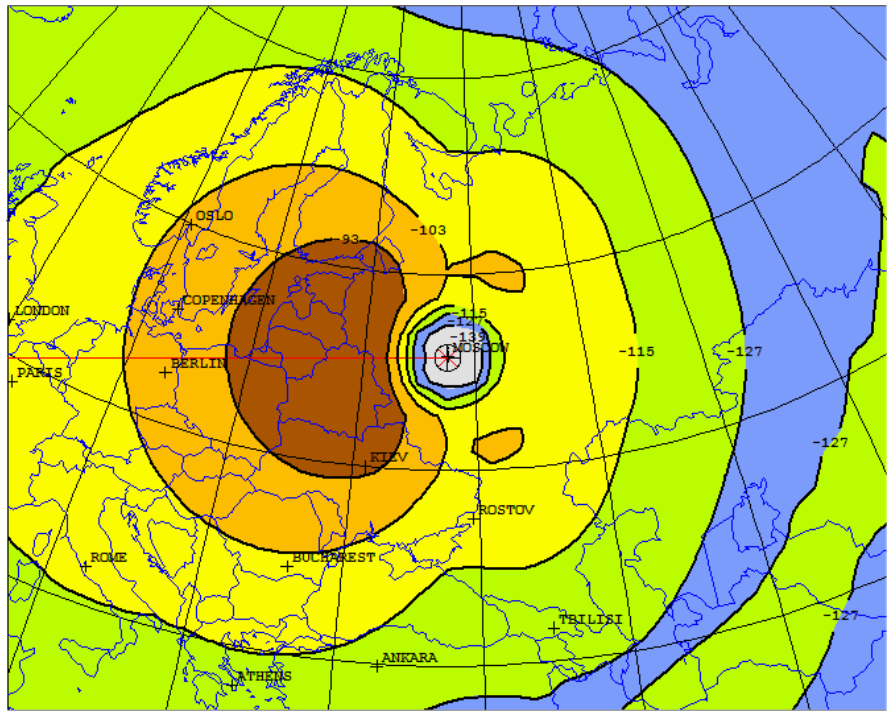


Skip Zone

f_oE_s multiplying factor = 2.0 in *VOAAREA*

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

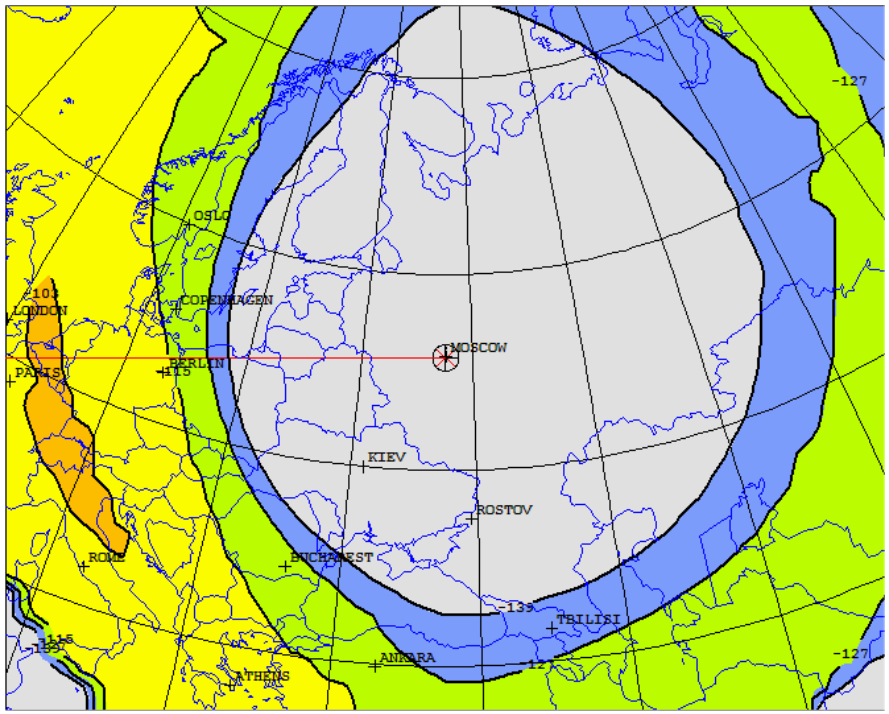




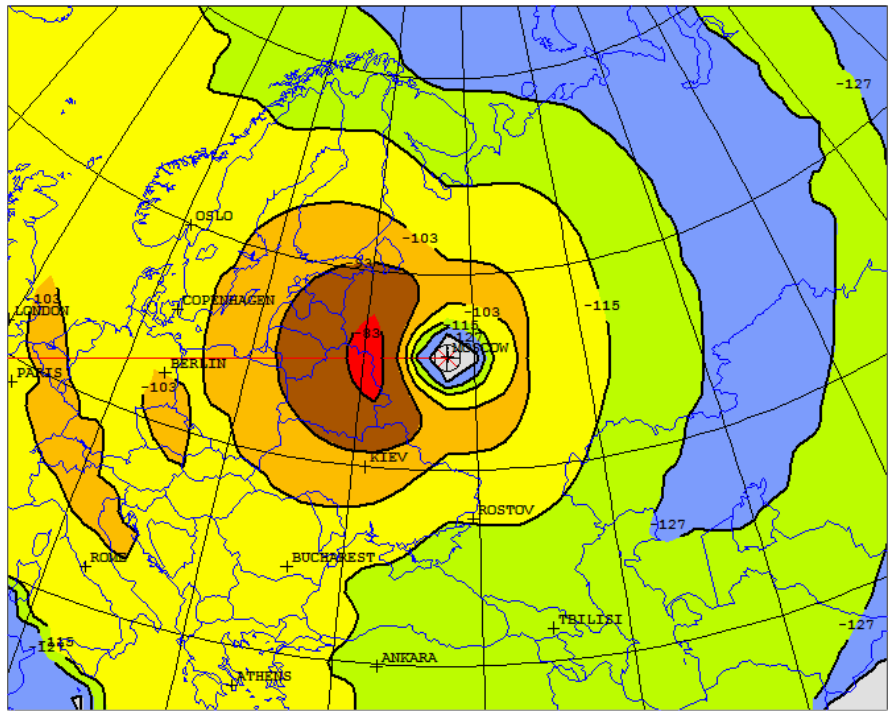
Without Sporadic-E

With Sporadic-E

Side-by-Side Comparisons for Europe: July, 2010, 12 UTC (Daytime), 20 Meters



Without Sporadic-E

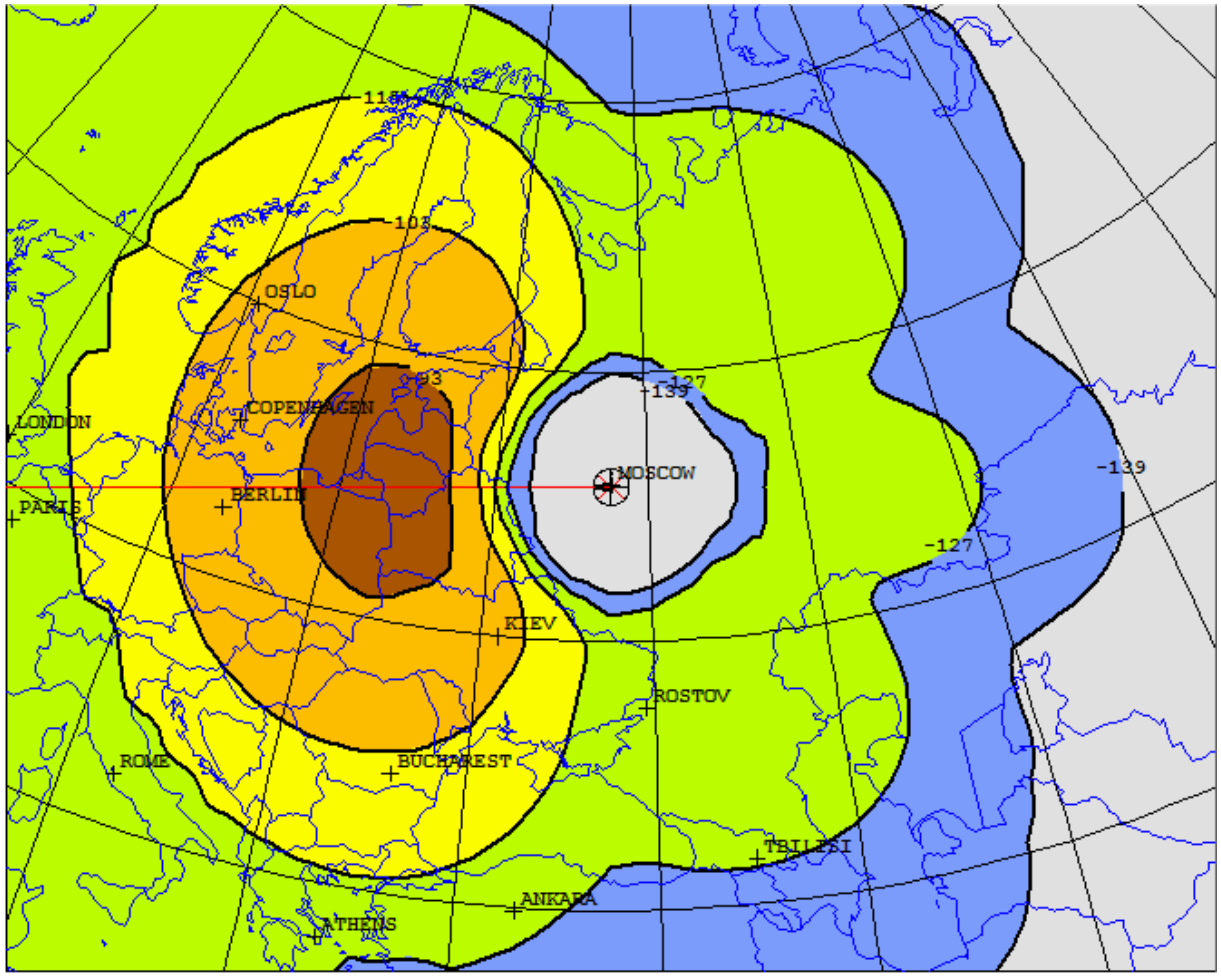


With Sporadic-E

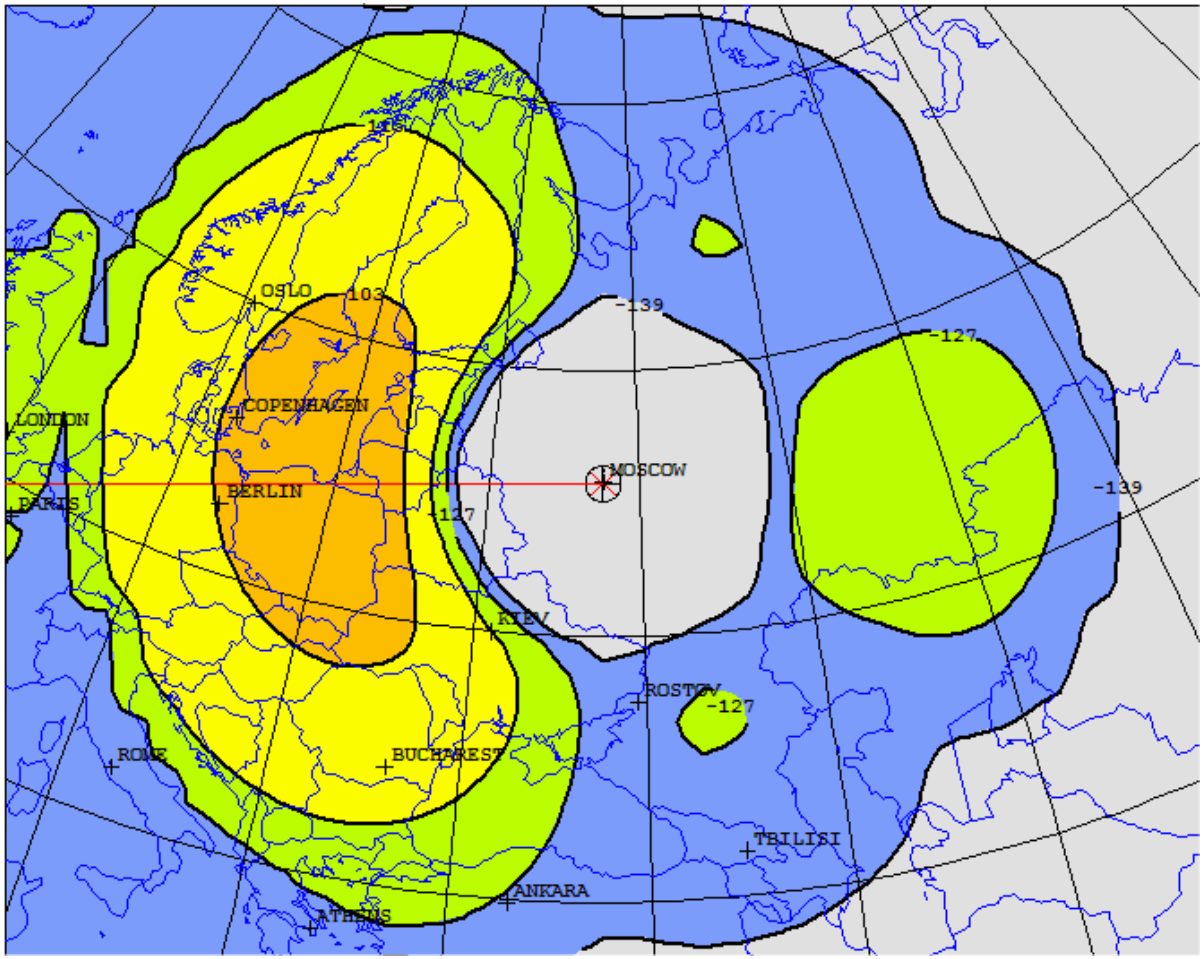
Zoomed-in on Europe: July, 2010, 03 UTC, 15 meters, Without E_s

Nada… no F_2 predicted at 03 UTC on 15

Zoomed-in on Europe: July, 2010, 03 UTC, 15 meters, With E_s Included.



Zoomed-in on Europe: July, 2010, 03 UTC, 10 meters, With E_s Included



Comments From KL9A About WRTC 2010

"As far as the E goes, there is no question that's what it was. It was consistently there, but changed a lot. I can tell you that 10 was open the entire contest. In the middle of the night we were hearing beacons to the west, but nobody on. Our quick CQs went un-answered. It was never very strong on 10 except for in small spurts. The northern EU guys were in a lot, but quite weak. The URs etc were always workable. Western EU was very, very sporadic."

Comments From KL9A About WRTC 2010

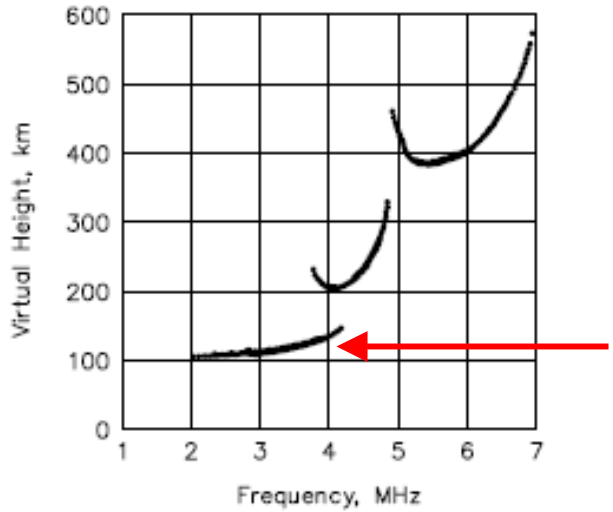
"Signal strengths on 15m were more spotty than 10 at times. The big HQ stations would be in there CQing away at S0 or S1, then we would get 30 minutes or an hour of LOUD guys and it would shut down again. Pretty classic E stuff."

"The only thing I remember about 20m is that everyone was super strong, all the time. I had no idea there was that many guys in UA0/9. No matter where we turned the antenna, it was an EU rate fest."

Ionosonde Records

• To verify the presence of Sporadic-E throughout Europe during WRTC 2010, we can also look over the records from various vertical ionosondes.

Vertical-Incidence Sounder (Ionosonde)



Sporadic-E not shown, but it would be around here at 105 km.

Fig 20—Very simplified ionogram from a vertical-incidence sounder. The lowest trace is for the E region; the middle for the F_1 and the upper trace for the F_2 region.

Pulses are sent upwards into the ionosphere (like a radar turned on its side). The frequency where the return echo disappears is the *critical frequency* for that region.

(Courtesy, *The ARRL Antenna Book)*

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• The rule of thumb for oblique F_2-layer propagation is that the MUF(3000) ≅ 3 times the F_2 critical frequency, f_oF_2.

• For Sporadic-E oblique propagation, the max single-hop MUF(2000) ≅ 5 times the E_s critical frequency, f_oE_s.

Caveats, Ionosonde Records

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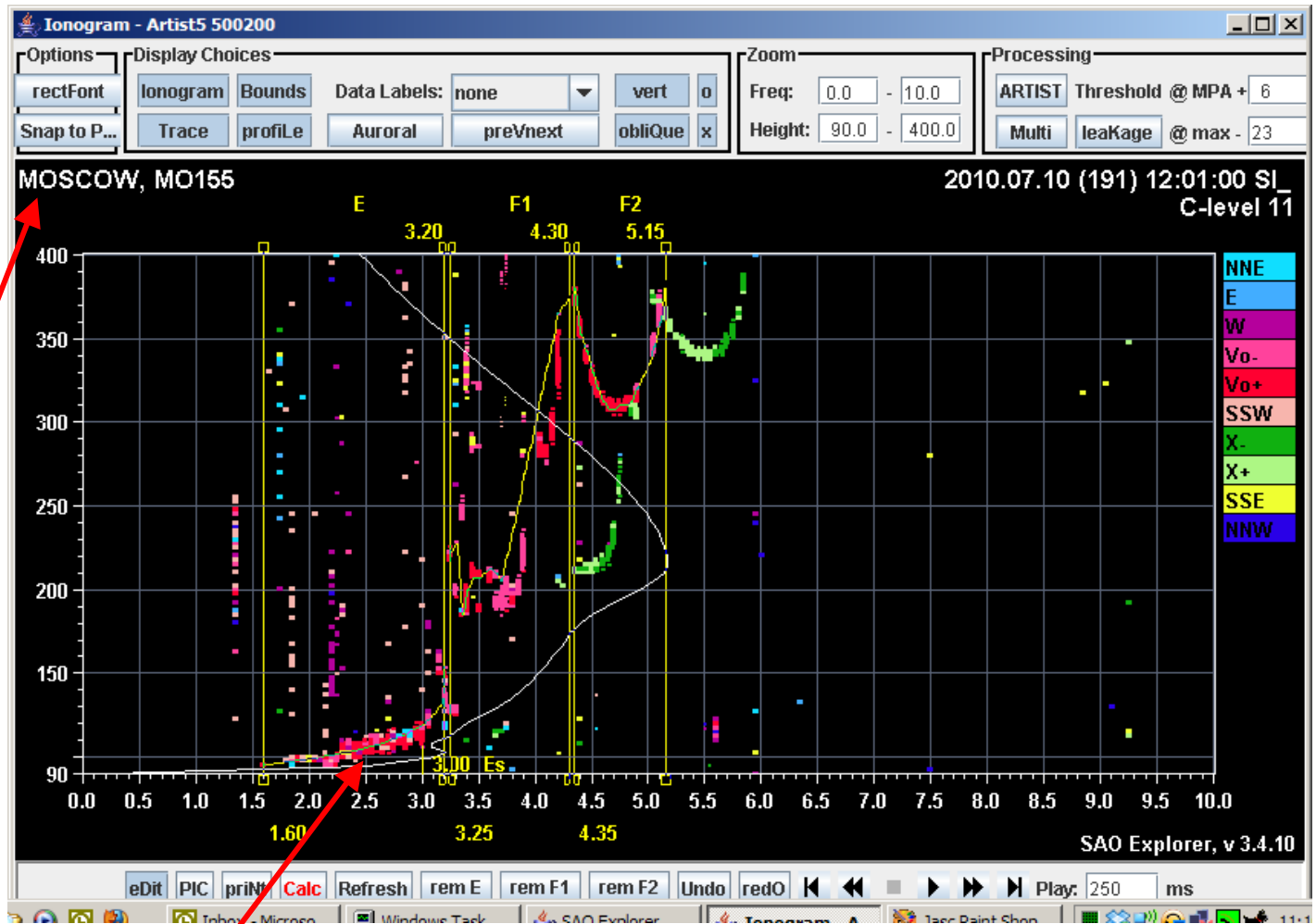
- Automatic scaling and critical-frequency algorithms can sometimes get fooled on the ionograms.
- Multiple propagation modes can and do occur, with E-region modes mixed in with Sporadic-E, F_1 and F_2 modes simultaneously.
- Sporadic-E propagation is characterized by unusually strong signals that fill in the normal F_2-region skip zone.

Ionosonde Records

Near London

Moderate E_s layer at 110 km height in Zone 27 at the start of the contest.

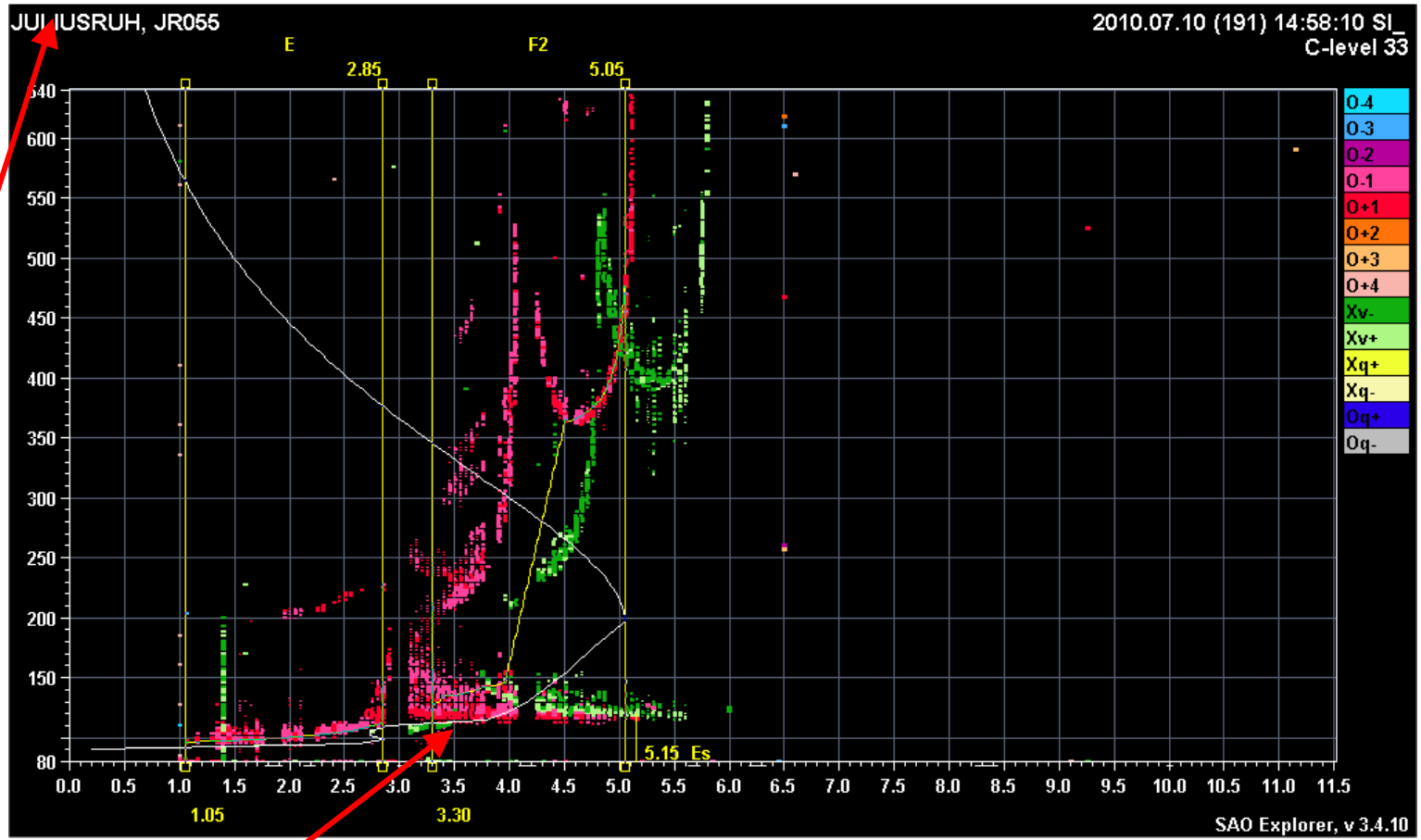
Ionosonde Records



Moscow

Moderate E_s mixed with regular E-region.

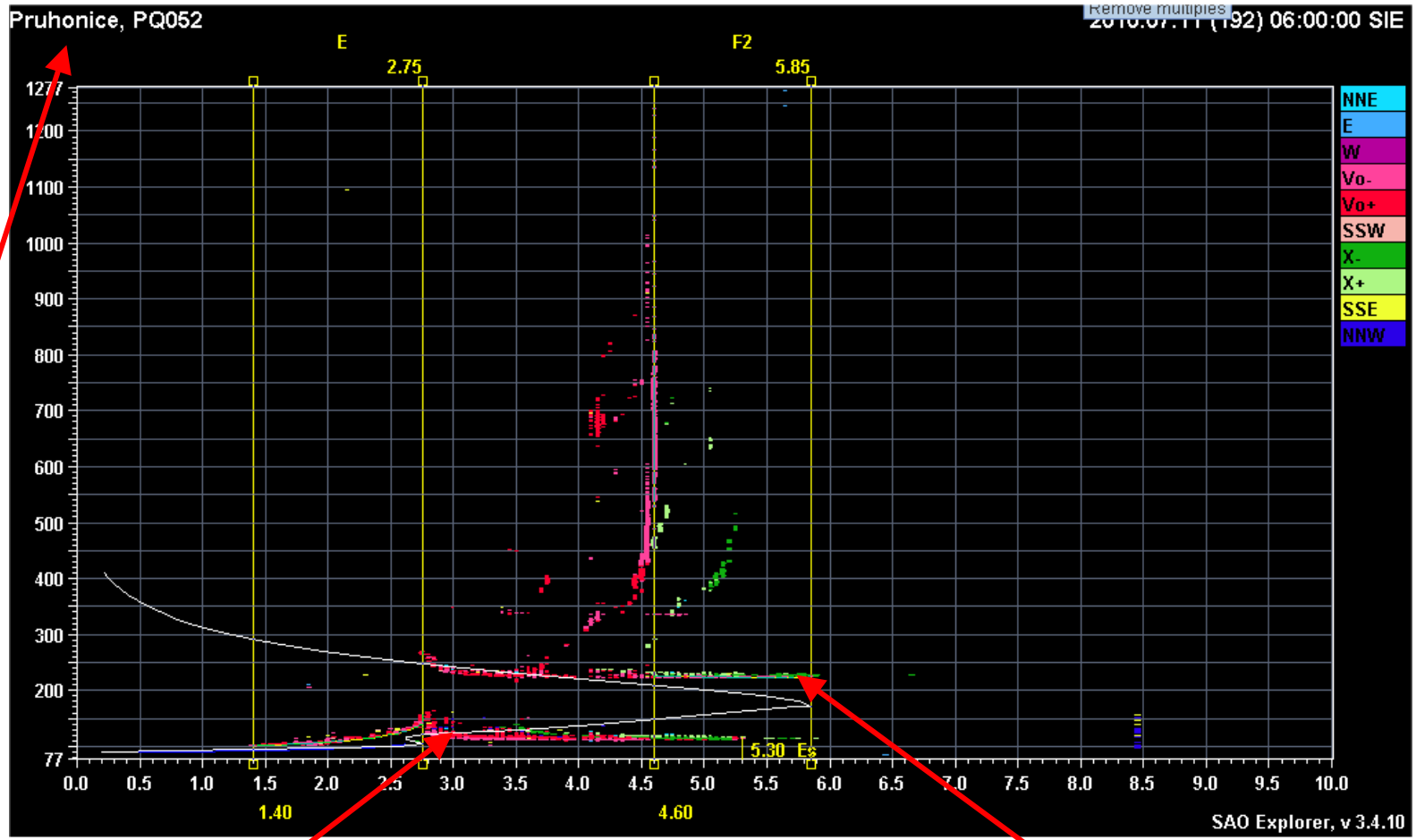
Ionosonde Records



Near Berlin

Strong E_s around Berlin in Zone 28.

Ionosonde Records



Near Prague

Very strong E_s around Prague in Zone 28. Note the 2nd echo. E_s is strong enough to blank F_1 layer.

Propagation During WRTC 2010

• These ionogram examples don't definitively *prove* that Sporadic-E was causing short-skip propagation during WRTC, at least on a minute-by-minute basis between specific locations. Sporadic-E is *sporadic*, after all.

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• If it walks like a duck, and talks like a very loud duck… it's probably Sporadic-E!

"It's like *déjà vu* all over again…" (Yogi Berra) — Log from N6BV/1 IARU 1996

DATE	TIME	MODE	NUMBER	FREQ	CALL	RCVD	NEW MULTS		PTS
13-Jul-96	1917	CW	51	28018	K8CV	599	08		1
13-Jul-96	1917	CW	52	28018	K8QLK	599	08		1
13-Jul-96	1917	CW	53	28018	DK3DG	599	28		5
13-Jul-96	1918	CW	54	28018	AA2Z	599	08		1
13-Jul-96	1918	CW	55	28018	DL1JU	599	28		5
13-Jul-96	1918	CW	56	28018	KG0KR	599	07		3
13-Jul-96	1919	CW	57	28018	PA0MIR	599	27	27	5
13-Jul-96	1919	CW	58	28018	DL1AKZ	599	28		5
13-Jul-96	1920	CW	59	28018	AA0NB	599	7		3
13-Jul-96	1921	CW	60	10	OL9HQ	599	CRK	CRK	1
13-Jul-96	1922	CW	61	10	WB0OLA	599	08		1
13-Jul-96	1922	CW	62	28018	N9AG	599	08		1
13-Jul-96	1922	CW	63	28018	K0DN	599	07		3
13-Jul-96	1923	CW	64	28018	SV1DPJ	599	28		5
13-Jul-96	1923	CW	65	28018	K9OM	599	08		1
13-Jul-96	1924	CW	66	28018	LU1EWL	599	14	14	5
13-Jul-96	1924	CW	67	28018	KA7WDM	599	6		3
13-Jul-96	1925	CW	68	28018	PA0JED	599	27		5
13-Jul-96	1925	CW	69	28018	DL2HWB	599	28		5
13-Jul-96	1925	CW	70	28018	G3ESF	599	27		5
13-Jul-96	1926	CW	71	28018	PA0JR	599	27		5
13-Jul-96	1926	CW	72	28018	ON4UBA	599	UBA	UBA	1
13-Jul-96	1926	CW	73	28018	DL3KUD	599	28		5
13-Jul-96	1927	CW	74	28018	ON7SS	599	27		5
13-Jul-96	1927	CW	75	28018	DL3KDV	599	28		5
13-Jul-96	1927	CW	76	28018	G3TXF	599	27		5
13-Jul-96	1927	CW	77	28018	HA5CW	599	28		5
13-Jul-96	1928	CW	78	28018	SR5W	599	28		5
13-Jul-96	1928	CW	79	28018	DL3JZN	599	28		5
13-Jul-96	1928	CW	80	28018	ON4ALW	599	27		5

There's no way 10-meter F_2 would be so wide open to both Europe and short-skip stateside from W1, in July, during a sunspot low, except for Sporadic-E.

Sporadic-E Made WRTC 2010 Super!

• So, as has occurred in past years, in 2010 strong Sporadic-E clouds from the end of May to early August were all over Europe and they provided excitement on the upper HF bands (and 6 meters too).

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• Without short-skip E_s in Europe, how could the ops at WRTC 2010 work almost 3,600 QSOs in 24 hours, an amazing *average* of 150 QSOs per hour?

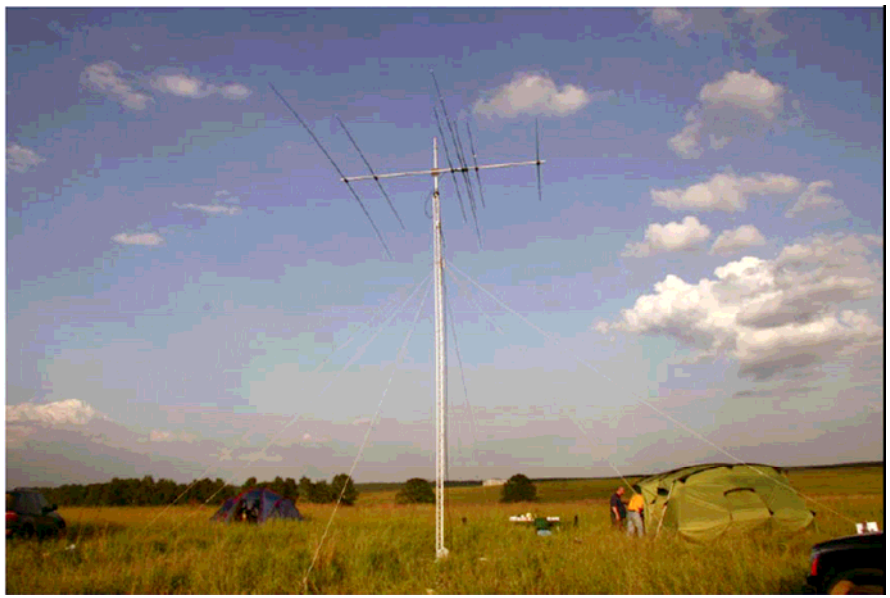
R33M Rate Sheet, WRTC 2010

CALLSIGN: R33M
OPERATORS: KL9A, N6MJ

QSO Rate Summary									
Hour	160	80	40	20	15	10	Rate	Total	Pct
1200	0	0	35	162	17	12	226	226	6.2
1300	0	0	33	92	25	0	150	376	4.1
1400	0	0	82	87	7	0	176	552	4.8
1500	0	0	70	77	17	4	168	720	4.6
1600	0	0	87	63	1	3	154	874	4.2
1700	0	0	119	12	20	14	165	1039	4.5
1800	0	100	19	18	16	2	155	1194	4.2
1900	0	10	98	29	14	1	152	1346	4.1
2000	0	126	31	56	0	0	213	1559	5.8
2100	0	77	73	5	0	0	155	1714	4.2
2200	0	102	8	27	0	0	137	1851	3.7
2300	0	43	40	0	0	0	83	1934	2.3
0000	0	38	23	12	0	0	73	2007	2.0
0100	0	0	37	42	0	0	79	2086	2.2
0200	0	0	31	92	2	0	125	2211	3.4
0300	0	0	11	95	8	9	123	2334	3.4
0400	0	0	0	105	29	17	151	2485	4.1
0500	0	0	0	94	46	13	153	2638	4.2
0600	0	0	0	103	26	27	156	2794	4.3
0700	0	0	1	93	82	11	187	2981	5.1
0800	0	0	0	11	106	48	165	3146	4.5
0900	0	0	0	74	88	1	163	3309	4.4
1000	0	0	0	94	73	3	170	3479	4.6
1100	0	0	0	94	21	9	124	3603	3.4
Total	0	496	798	1537	598	174	3603		

Level Playing Field?

• The Russians literally set up on “level playing fields” for WRTC 2010, since they used flat agricultural land for each of the 48 competitors.



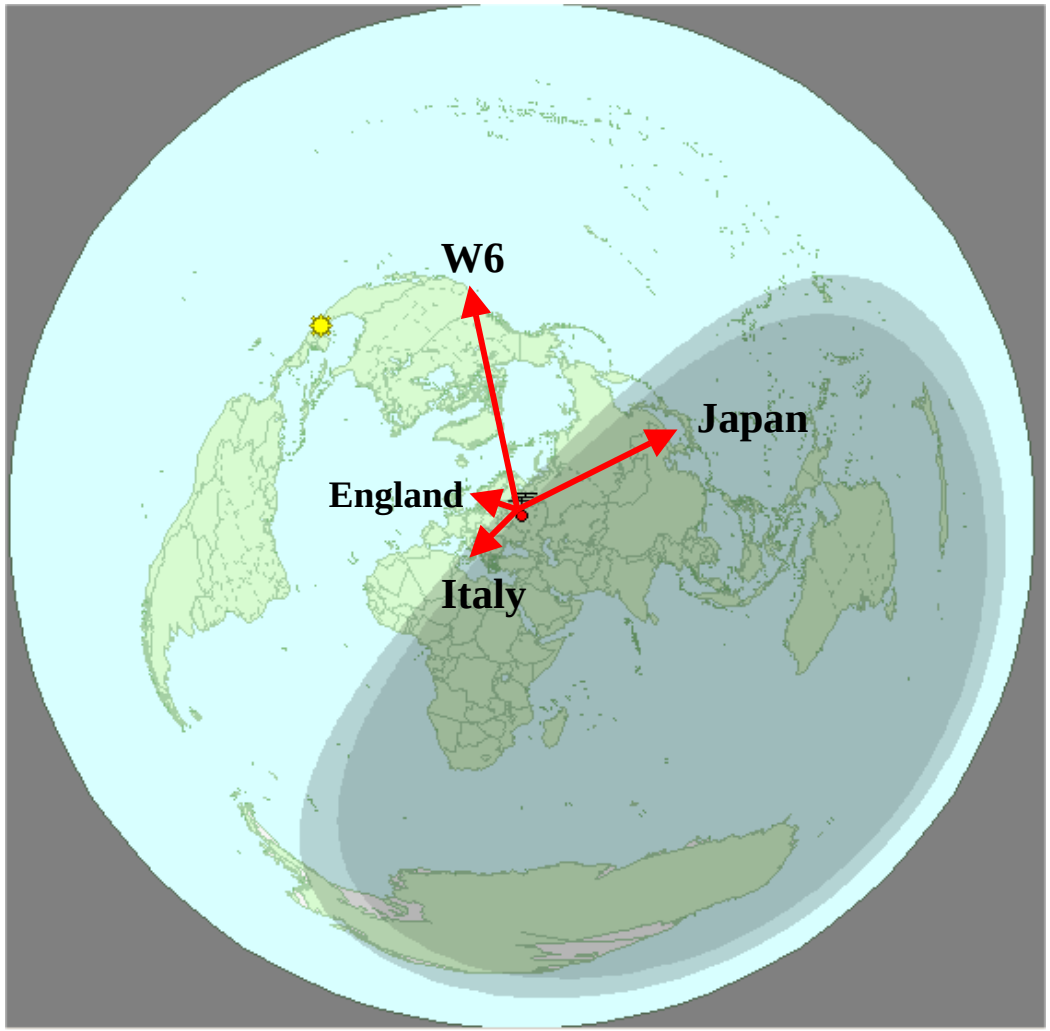
Photo, courtesy EY8MM

Level Playing Field

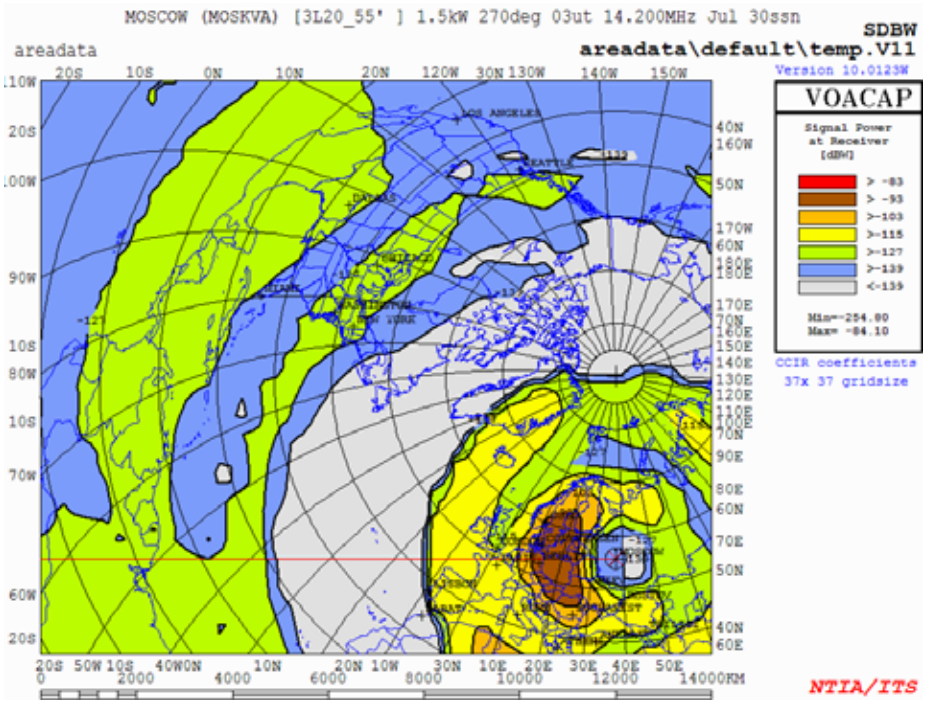
• The Russians literally set up on “level playing fields” for WRTC 2010, since they used flat agricultural land for each of the 48 competitors.

• Any differences in signal strength came about because the competitors had their antennas turned in different directions at different times.

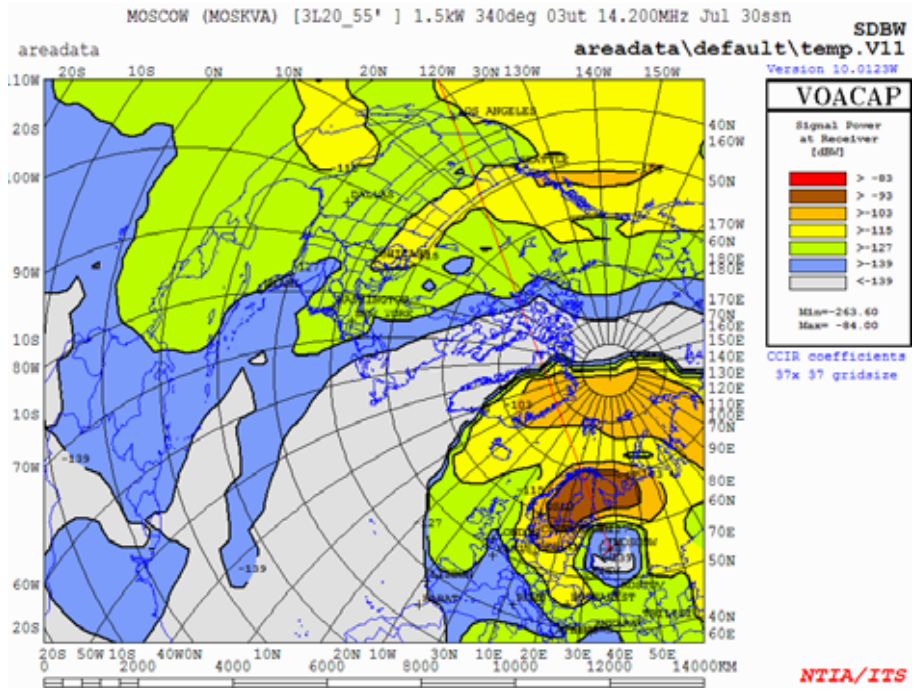
Azimuths for Competition in Moscow



Antenna Aiming from Moscow



Aimed at Europe



Aimed at W6

But except to work multipliers, why would you point your beam away from the big pileups in Eastern Europe?

Wrap up

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• However, propagation is *always* changing and you've got to be on top of how things are actually going during a contest.

• Sporadic-E happens predictably — usually right during the IARU contest in early July. That's the back story.

• Being aware of what is *actually* happening on the bands and exploiting these conditions helps separate the also-rans from the winners!

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.

For a pdf of this presentation:

http://tinyurl.com/29r5g64

- Thank you, Chris, KL9A, for R33M log data.