24 GHz Tests between VK7MO and OK1KIR and G3WDG (31 December 2014)

A good result in that with OK1KIR the OK ODX was extended to 16438 km and with G3WDG the World 24 GHz EME Record was extended to 17464 km.

These results follow careful planning after analysis of losses due to degradation, spreading, common window/elevations as well as Precipitable Water (PW), cloud and rain. It turns out that only a few days each month are potentially suitable for such long distance QSOs and then one must also have low PW and no cloud or rain. On the three previous months we planned these tests cloud or rain prevented us even making an attempt. On this occasion we were lucky in that there was clear skies at both ends.

VK7MO Location at QE36wv

Fig 1: Location at QE36wv on the Tasman Peninsular

The location was chosen to be as far as one can be away from the UK in Tasmania or Australia and still have a good take-off to Moon-set. As shown in Figs 2,3&4 the good take-off was only because a section of the forrest had been recently cleared. The distance is about 60 km greater than the previous World Record from G3WDG to VK7MO at Mt Wellington. But did not have the advantage of Mt Wellington's 1270 metre height to reduce atmospheric absorption - although this was compensated by both stations having 3 dB more power.

Fig 2: Location in a Forrest Clearing with a good take-off to Moon-set as in Figs 3 & 4

Fig 3: VK7MO Operating location

Fig 4: Take-Off to moon-set - red arrow shows operating location

Equipment

VK7MO portable station: 1.14 meter dish and 20 watts fully GPS locked and corrected for Doppler.
OK1KIR: 4.5 meter dish and 22 watts output transverter GPS locked
G3WDG: 3 metre dish and 18 watts output, transverter GPS locked
For the previous World Record VK7MO and G3WDG only had 10 watts available.

Planning

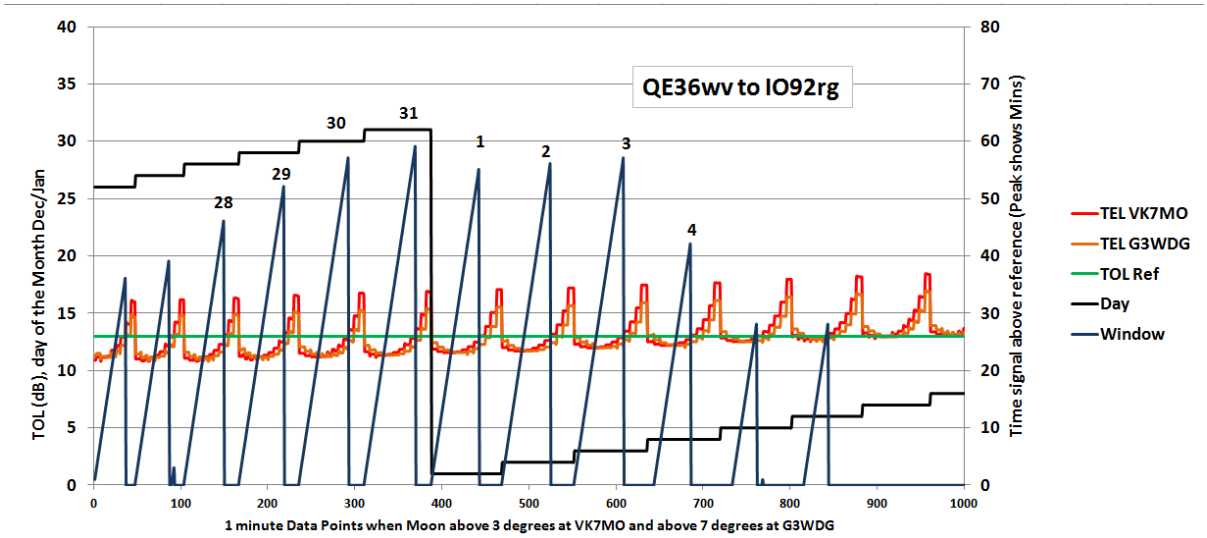


Fig 5: Planning Chart

Fig 5 shows the chart used for planning. The red and orange lines are the total extra losses based on degradation and spreading and due to PW (estimated at 15 mm both ends and assuming no cloud or rain) as it varies with elevation. The green line is the reference Total Extra

Loss of 13 dB, which we have found can be tolerated for our systems. A correction of 1.5 dB is applied to reflect the gain of G3WDG's dish compared to W5LUA's dish which we use as a reference. The blue saw-tooth lines show the time that is available for a QSO when the Total Extra Losses are below the reference and it is seen that the maximum time is 31 December at about 58 minutes. Even at the best there is only 2 dB to spare and this can be lost with just light cloud at either end.

Conditions on the day

It turned out that the moon was in the clear for both G3WDG and VK7MO for the duration of the tests and this made for relatively quick QSOs. PW at Hobart airport at 12Z was 19.9 mm and at Nottingham 82 km from G3WDG it was 8.65 mm. Surface extrapolation by G3WDG estimates the PW at his location at 14 mm. While the Nottingham radiosonde data gives the best estimate of the upper air PW the surface extrapolation takes better account of local surface PW. The best we can do is estimate the PW based on half way between at 11 mm. While we were fortunate in having no cloud for the duration of the QSOs between G3WDG and VK7MO there was cloud prior to and at the end of the tests and we noticed that when cloud was present we lost even the 1270 Hz single tone - so undoubtedly we were very lucky to have clear skies for the QSOs.

At OK1KIR PW was 12.86 mm and there was 3264 metres of cloud as well as heavy rain in the direction they had to beam (refer Attachment A).

Comparison of Conditions with Earlier World Record from Mount Wellington

Parameter	**Mt Wellington**	**Tasman Peninsular**
Degradation Loss	**1.2 dB**	**1.2 dB**
Spreading	180 Hz	154 Hz
Effective Spreading	110 Hz	94 Hz
Spreading Loss	**6.7 dB**	**6.5 dB**
PW VK7MO	6 mm	19.9 mm
PW G3WDG	12.2 mm	Use 11 mm
Total of Elevations for both ends	22 degrees	21 degrees
Best PW Loss	**3.2 dB**	**5.4 dB**
Less G3WDG Gain over W5LUA reference	**1.5 dB**	**1.5 dB**
Total Extra Loss	**9.6 dB**	**11.6 dB**

As seen above conditions were 2 dB worse for the Tasman Peninsular test but this is offset by the fact that we are running almost 3 dB more power - thus we should be about 1 dB in front. In fact the QSOs were much easier from the Tasman Peninsular reflecting the 1 dB improvement (there was also cloud present for much of the time during the Mt Wellington test). The Total Extra Losses of 11.6 dB for the Peninsular test can be compared with the 13 dB Total extra loss limit we have found in other tests (with the same TX power). Thus there was around 1.4 dB to spare which is consistent with the fact that we completed two fairly easy QSOs with G3WDG.

Range of DT window for JT4f

Tests have been conducted to determine the range over which JT4 is effective for decoding within a DT window. These are compared below with similar tests for JT65.

Mode	Minimum	Maximum
JT4	-1.6 seconds	+5.7 seconds
JT65	-2 seconds	+10 seconds

From the above it is seen that JT4 timing is more critical than JT65.

Results

Green highlighting indicated good DT

All Txt File at VK7MO

125800 Transmitting: JT4F @1270
125900 0 -21 1.4 -33 15 *
130100 0 -21 3.0 61 4 #
130207 Transmitting: JT4F @1000 (RRR)
130300 0 -21 0.3 28 15 *
130410 Transmitting: JT4F OK1KIR VK7MO QE36
130500 0 -21 -1.0 35 7 #
130700 0 -21 -0.7 15 20 * **Good Signals on the Waterfall but no good syncs**
130900 0 -20 -1.2 46 18 *
131100 0 -21 3.9 55 7 #
131300 0 -21 -0.5 20 4 *
131500 0 -21 -0.4 9 7 *
131700 2 -19 5.2 4 7 *
131900 1 -19 2.2 77 9 *
132100 0 -21 -0.6 0 7 * **Still no good syncs**
132300 6 -15 4.8 20 59 # VK7MO OK1KIR -16 1 9 E
OK1KIR corrected by 1.5 seconds and DT is now within range of 5.7 seconds so presumably it was around 4.8+1.5=6.3 and thus recorded DT above was just on random noise and not meaningful.
132401 Transmitting: JT4F OK1KIR VK7MO R-15
132500 0 -21 5.2 -4 4 # **Received RRR**
132602 Transmitting: JT4F @1700 (73)
132700 0 -21 3.8 85 4 *
132900 0 -20 1.0 -9 4 #
133000 Transmitting: JT4F OK1KIR VK7MO QE36
133100 0 -20 -1.5 50 9 *
133300 0 -20 2.5 -42 4 #
133500 0 -21 3.0 101 7 #
133600 Transmitting: JT4F @1000 (RRR)
133700 1 -20 2.9 -31 7 *
133900 0 -21 3.7 20 11 #
134100 0 -21 4.4 96 4 #
134300 0 -21 4.1 44 4 #
134400 Transmitting: JT4F @1270
134500 0 -21 1.4 42 20 *

134700 1 -20 3.0 46 4 *
134900 0 -20 -1.1 -61 4 *
135100 0 -21 2.6 477 4 # **Split 1270 Hz tone**
135200 Transmitting: JT4F @1000 (RRR)
135300 3 -18 2.6 -39 59 *
135403 Transmitting: JT4F G3WDG VK7MO QE36
135500 3 -18 2.6 -42 44 *
135500 2 2/2 VK7MO G3WDG IO92 0 6 **Decoded on average of 2**
135607 Transmitting: JT4F G3WDG VK7MO -18
135700 3 -17 2.6 -55 63 *
135700 2 3/3 VK7MO G3WDG IO92 ? 0 3
135900 0 -21 1.3 -50 4 #
135900 2 4/4 VK7MO G3WDG IO92 ? 0 3
135900 0 -21 1.3 -50 4
135900 2 3/3 VK7MO G3WDG IO92 ? 0 3
140100 2 -19 2.3 -59 68 # VK7MO G3WDG R-17 0 13 E **Single line decode**
140201 Transmitting: JT4F @1500 (RRR)
140300 1 -20 5.6 -28 7 *
140400 Transmitting: JT4F G3WDG VK7MO QE36
140500 2 -18 2.3 -59 66 *
140700 3 -17 2.3 -66 53 *
140900 2 -19 2.4 -72 28 * VK7MO G3WDG IO92 0 17 D **Single line decode**
141004 Transmitting: JT4F G3WDG VK7MO -19
140900 2 1/1 VK7MO G3WDG IO92 0 17
141100 3 -18 2.4 -59 74 *
141100 2 2/2 VK7MO G3WDG IO92 0 12
141300 1 -20 2.4 -33 46 #
141500 3 -18 2.4 -63 39 #
141500 2 2/2 VK7MO G3WDG R-18 ? 0 2 **Decoded on Average of 2**
141600 Transmitting: JT4F @1500 (RRR)
141700 0 -21 4.4 -81 7 #
141800 Transmitting: JT4F @1700 (73)
141900 0 -20 1.1 -125 4 *
142024 Transmitting: JT4F HNY CH AND PE
142100 0 -21 2.4 -74 46 *
142300 2 -18 2.4 -59 61 *
142500 1 -19 2.7 -59 72 *
142700 0 -21 2.5 -68 7 *
142900 1 -20 4.2 -116 4 #
143100 0 -20 2.7 -72 7 *
143300 0 -20 -1.2 -98 7 *
143500 0 -20 3.0 -116 7 *
143700 0 -21 3.1 -61 7 *
143856 Transmitting: JT4F @1500 (RRR)
143900 1 -19 1.8 20 11 *
144000 Transmitting: JT4F @1270
144100 1 -20 3.4 -37 18 #
144300 0 -20 4.0 4 7 #
144500 0 -21 5.1 46 4 #

VK7MO gained 15 good syncs from G3WDG Note that two QSOs were completed and with some single line decodes indicating there was something in reserve.

RXed by OK1KIR
OK1KIR in JN79DW and VK7MO in QE36wv
UTC Date: 2014 Dec 31

125843 Transmitting: JT4F @1270
130200 2 -19 -1.6 -66 7 *
130300 Transmitting: JT4F VK7MO OK1KIR JN79
130400 3 -17 -0.9 155 44 * **Note Good DTs are around -0.9 seconds**
130600 4 -16 -0.9 158 50 * OK1KIR VK7MO QE36 0 22 E
130600 1 3/3 OK1KIR VK7MO QE36 0 7
130701 Transmitting: JT4F VK7MO OK1KIR R-16 *(shortly ticked Tx3 message instead of Tx2)*
130709 Transmitting: JT4F VK7MO OK1KIR -16 *(corrected to Tx2 message)*
130800 5 -15 -0.9 155 46 * OK1KIR VK7MO QE36 0 31 C
130800 1 4/4 OK1KIR VK7MO QE36 0 26
131000 5 -15 -0.9 158 46 *
131200 4 -16 -0.9 158 48 * OK1KIR VK7MO QE36 0 8 D
131200 1 2/2 OK1KIR VK7MO QE36 1 5
131400 3 -17 -0.9 158 53 * OK1KIR VK7MO QE36 0 8 F
131400 1 3/3 OK1KIR VK7MO QE36 1 6
131600 2 -19 -1.0 160 44 * OK1KIR VK7MO QE36 ? 0 5 D
131600 1 4/4 OK1KIR VK7MO QE36 1 9
131800 1 -20 -0.9 166 44 *
131800 1 5/5 OK1KIR VK7MO QE36 1 10
132000 3 -17 -1.0 162 50 * OK1KIR VK7MO QE36 0 8 E
132000 1 6/6 OK1KIR VK7MO QE36 1 10
132200 3 -18 **-1.0** 158 50 *
132200 1 7/7 OK1KIR VK7MO QE36 1 7 ***(DT changed to +1.5 sec !!)***
132358 3 -17 **0.5** 160 53 # OK1KIR VK7MO R-15 0 12 D DT now 0.5 seconds
132358 1 7/7 OK1KIR VK7MO QE36 1 7
132358 2 1/1 OK1KIR VK7MO R-15 0 12
132513 Transmitting: JT4F @1500 (RRR)

132700 Transmitting: JT4F @1700 (73)
132801 1 -20 -1.0 -48 20 *
133001 1 -19 -1.2 424 31 #
133100 Transmitting: JT4F @2000
133201 0 -21 -0.1 -359 77 #
133315 Transmitting: JT4F @1270
133401 2 -19 -1.6 333 15 #
133601 1 -19 0.2 -63 18 *
- - - - - - - - - the end of OK1KIR-VK7MO - - - - - - - - - - - - - -

135001 2 -19 1.1 -50 37 #
135101 0 -21 4.5 -238 28 #
135201 0 -21 2.2 269 18 #
135301 6 -15 1.0 258 31 * VK7MO G3WDG IO92 1 0 D **DT now 1 second when one would expect 0.5 seconds**
135401 1 -19 5.6 420 26 #
135501 6 -15 1.1 -411 28 * VK7MO G3WDG IO92 1 0 D
135558 0 -20 4.2 -238 44 #
135658 5 -15 4.2 -422 31 * VK7MO G3WDG IO92 1 0 D **Strange Jump in ST**
135758 2 -19 4.2 208 70 #
135758 1 5/5 VK7MO G3WDG IO92 1 0
135758 2 7/7 VK7MO G3WDG IO92 1 0
135858 5 -16 3.8 -48 28 #

135958 0 -21 -0.9 -713 9 *
140058 6 -14 3.8 -81 26 # VK7MO G3WDG R-17 1 0 D **DT is varying again**
140158 0 -21 0.5 -381 44 #
140259 0 -21 -0.5 96 26 *
140359 0 -20 5.0 210 68 *
140459 4 -16 2.7 -136 26 * HNY HNY 2015 1 0 D **DT is varying again**
140559 0 -21 1.0 -376 66 *

Comment: It seems the DT is varying for some unknown reason which might explain the problem with DT setting at the time of QSO with VK7MO

G3WDG

Ran two PCs in real time per the previous post processing experiment. Settings were initially the same on both (DF and MinW = E) , then switched the postprocessing machine to D midway and it seemed slightly better, but did not decode anything the main machine didn't.

Calc PW from 6C 85% RH = 14mm. Was 11 yesterday – new air coming in together with the clouds today. Been frosty/clear here for several days, and wx forecasts have been spot on.

Here's all.txt from main machine

UTC Date: 2014 Dec 31

134400 0 -20 1.8 -413 15 *
134500 Transmitting: JT4F @1270 (TUNE)
134600 0 -20 5.7 -518 20 *
134800 0 -21 -0.1 -81 22 #
134916 Transmitting: JT4F @1000(TUNE)
135000 2 -19 2.5 -79 48 *
135200 0 -21 -0.9 -142 15 #
135300 Transmitting: JT4F VK7MO G3WDG IO92
135400 1 -20 2.5 -70 26 * **VK7MO Txing Calls and Grid**
135600 2 -19 2.5 -61 48 # **VK7MO Txing calls and report**
135800 3 -17 2.9 -63 66 # G3WDG VK7MO -18 0 10 E **Single line decode**
135800 1 2/2 G3WDG VK7MO -18 ? 0 3
135907 Transmitting: JT4F VK7MO G3WDG R-17
140000 3 -17 2.9 -68 63 # G3WDG VK7MO -18 0 1 F
140000 1 3/3 G3WDG VK7MO -18 1 5 **Convolutional decode on average**
140200 0 -21 2.1 -48 15 * **VK7MO Txing RRR**
140300 Transmitting: JT4F @1700 (73)
140400 2 -18 2.9 -61 44 * **VK7MO TXing calls and grid**
140500 Transmitting: JT4F HNY HNY 2015
140600 2 -18 2.9 -66 50 *
140800 1 -20 2.9 -46 39 *
140900 Transmitting: JT4F VK7MO G3WDG IO92
141000 0 -20 5.3 -133 11 # **VK7MO Txing calls and report**
141200 3 -18 2.7 -55 50 # G3WDG VK7MO -19 0 2 E
141310 Transmitting: JT4F VK7MO G3WDG R-18
141400 4 -17 2.6 -55 72 #
141600 0 -21 0.7 -48 15 * **VK7MO Txing RRR**

141700 Transmitting: JT4F @1700 (73)
141800 0 -21 5.7 -92 26 # **VK7MO Txing 73**
141903 Transmitting: JT4F HNY HNY 2015
142000 0 -20 -1.1 -63 13 # **VK7MO Txing test but 24 seconds late**
142200 4 -17 2.6 -26 46 *
142400 2 -18 2.6 -53 59 *
142600 2 -18 2.6 -42 53 *
142600 1 3/3 HNY CH AND PE 1 0 **Convolutional decodr on average of 3**
142800 0 -21 -0.8 4 9 #
142800 1 3/3 HNY CH AND PE 1 0
143000 0 -21 0.9 -85 33 *

G3WDG gained 11 good syncs

Here's all.txt from postprocess machine:

UTC Date: 2014 Dec 31

135600 2 -19 2.5 -61 46 #
135800 3 -17 2.9 -63 63 #
135800 3 -17 2.9 -63 63 # G3WDG VK7MO -18 0 10 E
140000 3 -17 2.9 -68 61 # G3WDG VK7MO -18 0 1 F
140200 0 -21 2.1 -48 15 *
140000 3 -17 2.9 -68 61 # G3WDG VK7MO -18 0 1 F
140000 1 6/6 G3WDG VK7MO -18 ? 0 1
140200 0 -21 2.1 -46 9 *
140200 1 7/7 G3WDG VK7MO -18 ? 0 2
140400 2 -18 2.9 -61 44 *
140600 2 -18 2.9 -66 50 *
140800 1 -20 2.9 -46 42 *
141000 1 -20 1.2 13 9 #
141200 3 -18 2.7 -55 50 # G3WDG VK7MO -19 0 9 D
141400 4 -16 2.6 -46 70 #
141600 0 -20 -1.1 -55 9 #
141800 0 -21 5.7 -92 26 #
142000 0 -21 5.7 -160 7 #
142200 4 -17 2.6 -26 55 *
142400 2 -18 2.6 -53 63 *
142600 2 -18 2.6 -42 50 *
142600 1 3/3 HNY CH AND PE 1 0

We seemed to be rxing you a little better today than you rxing us I think – more power here needed!! Made a board for 4 x 4915, now awaiting metalwork.

Comment for VK7MO: Not sure there is too much difference. Looking at it another way VK7MO gained 15 good syncs and G3WDG gained only 11 good syncs. If we take G3WDGs 11 good syncs and compare the reported signal levels with VK7MOs best 11 syncs the averages are essentially the same at -18.1 dB.

It is seen that as a result of having clear sky at both ends two QSOs were completed with G3WDG and signals were present for 42 minutes until cloud appeared at both ends compared to the 58 minutes predicted for no cloud.

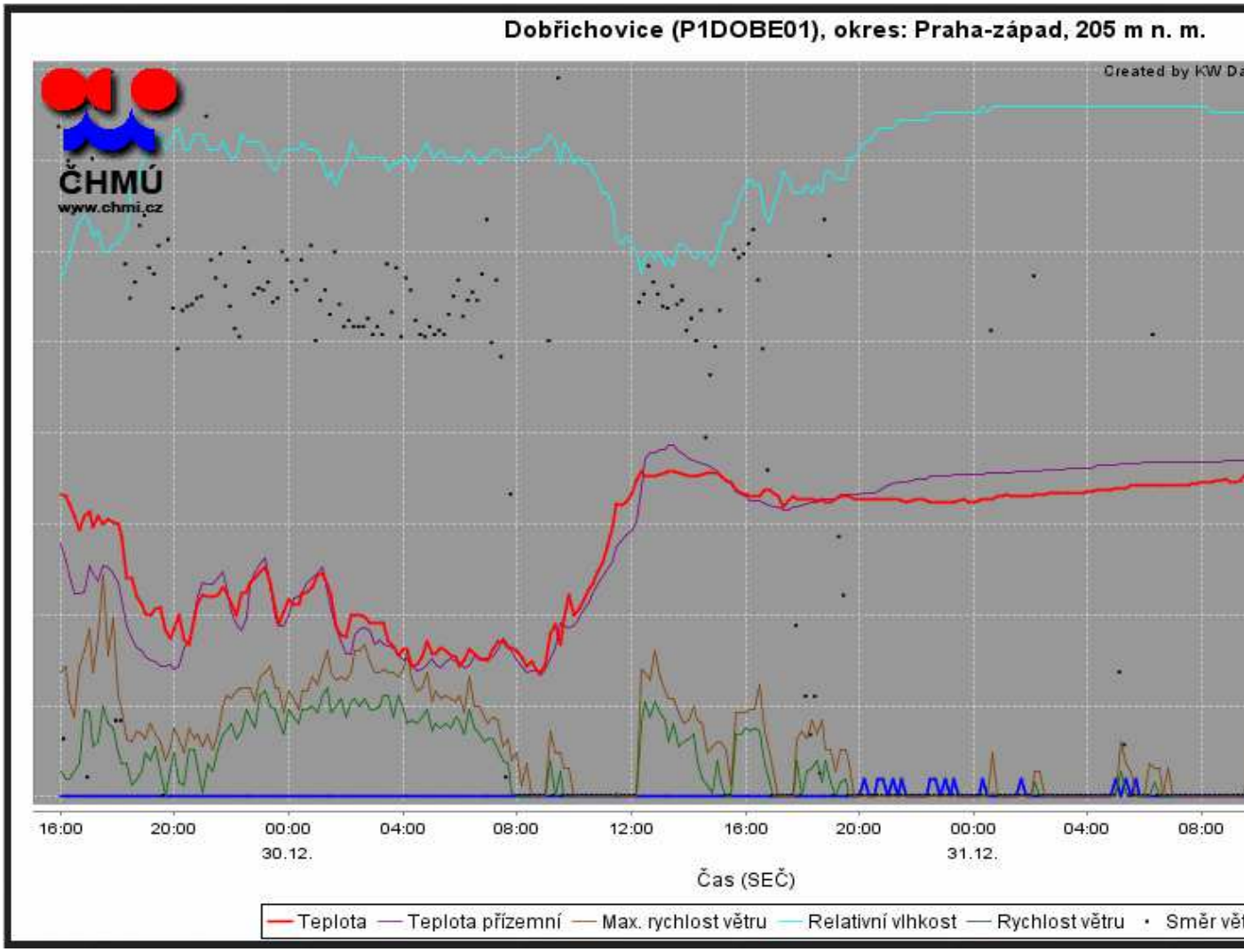
CONCLUSIONS

For such long distance QSOs on 24 GHz careful planning is critical (combined with some luck to have clear skies) and we are very close to the limit with the existing equipment and the VK7MO portable station.

Attachment A

Weather Data at OK1KIR

EU radar (unfortunately taken 2hrs after QSOs) explains by WX impacted tough 24G QSO OK1KIR(Az83/EL11.5) - VK7MO at 13:25UT with averaging employed, while following 24G QSO G3WDG - VK7MO (World Distance Record !) at 14:00UT was not limited by WX conditions.
During the G3WDG-VK7MO QSO OK1KIR (Az89/EL17) was almost unable to find and tune on the very weak JT4F signal from VK7MO.



Calculated PW ≈ 10 mm

11520 Praha-Libus Observations at 12Z 31 Dec 2014

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	271									
996.0	303	-0.9	-2.0	92	3.33	0	0	272.6	281.7	273.1
981.0	424	-2.3	-3.3	93	3.07	297	6	272.3	280.8	272.8
971.0	505	-1.8	-3.8	86	2.99	255	10	273.6	282.0	274.1
957.0	621	-1.1	-4.5	78	2.88	275	14	275.5	283.6	276.0
950.0	680	-0.7	-4.8	74	2.83	282	14	276.5	284.5	276.9
947.0	705	-0.9	-5.0	74	2.80	285	14	276.5	284.5	277.0
925.0	892	-2.3	-6.3	74	2.59	280	8	276.9	284.3	277.4
883.0	1258	-4.8	-6.7	86	2.62	290	6	278.0	285.6	278.5
857.0	1493	-6.5	-7.0	96	2.65	330	12	278.7	286.3	279.2
850.0	1558	-6.9	-7.1	98	2.65	325	12	278.9	286.5	279.4
842.0	1632	-7.4	-7.6	99	2.58	320	12	279.1	286.6	279.6
816.0	1875	-9.1	-9.2	99	2.35	359	12	279.9	286.7	280.2
813.0	1904	-8.9	-10.2	90	2.18	3	12	280.4	286.7	280.7
807.0	1962	-4.9	-25.9	18	0.58	12	12	285.2	287.1	285.3
805.0	1981	-3.9	-20.9	25	0.90	15	12	286.5	289.3	286.6
802.0	2011	-3.4	-15.9	37	1.39	20	12	287.3	291.6	287.5
799.0	2040	-2.9	-10.9	54	2.09	21	12	288.1	294.5	288.5
760.0	2436	-4.5	-8.9	71	2.58	33	20	290.6	298.4	291.0
741.0	2635	-5.1	-12.1	58	2.05	39	25	292.0	298.3	292.4
738.0	2667	-5.3	-12.5	57	1.99	40	25	292.1	298.2	292.4
724.0	2817	-6.5	-14.5	53	1.73	40	26	292.4	297.8	292.7
700.0	3079	-8.5	-13.5	67	1.94	40	27	293.0	299.1	293.4
687.0	3224	-9.3	-10.3	92	2.55	37	28	293.7	301.6	294.2
677.0	3337	-9.6	-10.4	93	2.56	35	29	294.6	302.5	295.1
619.0	4028	-11.3	-11.4	99	2.60	46	41	300.3	308.5	300.8
601.0	4254	-12.2	-12.7	96	2.40	50	45	301.9	309.5	302.3
574.0	4605	-13.5	-14.8	90	2.12	53	46	304.3	311.1	304.7
572.0	4632	-13.7	-15.8	84	1.96	53	46	304.4	310.7	304.7
550.0	4927	-16.2	-17.5	90	1.77	55	47	304.8	310.6	305.2
517.0	5392	-20.1	-20.1	100	1.51	49	49	305.5	310.5	305.8
511.0	5478	-19.5	-19.7	98	1.58	47	50	307.3	312.5	307.6
500.0	5640	-20.3	-21.7	89	1.36	45	51	308.2	312.8	308.5
412.0	7041	-30.3	-36.3	56	0.42	45	59	312.9	314.4	312.9
400.0	7250	-32.1	-38.1	55	0.36	45	60	313.2	314.5	313.3

Cloud Thickness 3264 metres

Precipitable water [mm] for entire sounding: **12.86**

⇨ Data above indicate from RH=f(height) heavy clouds up to 2km height and more

Local weather: totally uniformly cloudy and around 0degC