S51FB, S51ML, S52AA, S53WW

IARU R1 VHF Contest
Where are the limits?

1. Introduction

While playing with a database consisting of 146k QSOs that were made during 2014 September VHF contest, Matjaž/S51ML came to an idea to create some very interesting video clips and EU maps. His work was a trigger for us four to start digging through the data (it smelled like a "big data" project, hi) and creating even larger database from previous years contests (well done by S5 VHF Manager Miha/S51FB). This turned out not to be so simple and it is a pity that IARU R1 organization was not able to create and maintain a public repository of all the electronic logs that were received for September, October and June IARU R1 contests in the past (we all are well into the 21st century, but are we?). Not even the results of the VHF&up contests were available and maintained by IARU R1 VHF manager - we should thank to Matej/OK1TEH for all his effort in creating and maintaining the history of VHF&up activity in EU (www.ok2kkw.com). Anyway, we were able to find large enough number of electronic logs for contests back to year 2007 only.

Analysis of the data was mostly driven by the two main questions I put to myself, namely, how come that during last 29 years maximum achievable result (points and QSOs) was more or less constant, and how come, that not even the best station in the middle of the highest activity area cannot cross 1500 QSOs or more. As it normally happens when digging deeply into a matter, many interesting things show up, many new questions come up and some answers pop-up without questions being placed. So we decided to put the main findings into a presentation that was presented at 2015 RIS (a traditional January educational gathering of S5 amateur community). Presentation was only a starting point that, among other ideas, fired up a creation of a very interesting and insightful map of 2014 VHF contest activity by Peter/S52AA.

IARU R1 VHF Contest is the largest 2m contest in the world! Due to propagation characteristics on 144 MHz and due to the rules that allow contacts via "regular" propagation mode, i.e. troposcatter, it is really not possible to organize a true worldwide contest on 2m band. So the "worldwide" is actually just Europe. Never the less, IARU R1 VHF contest can be viewed as VHF equivalent of CQ WW DX contest.

2. Activity trends

Table and chart below show the amount of logs and number of different call signs for the September VHF contests from 2007 to 2014 that we had available for analysis. For none of those 8 years logs from all the countries with significant number of participants were available. Taking this into account and adding operators from multi op stations one can estimate that the total number of hams that are in one or another way active during the September contest is approaching 10.000, which is approx. 10% of all licensed radio amateurs in EU. **This number alone proves that this event is an important manifestation of significant ham radio activity on 2m band.**

Table shows number of logs, different call signs and QSO's made in IARU R1 VHF Contest from 2007 to 2014

	2007	2008	2009	2010	2011	2012	2013	2014
LOGS	824	1311	976	1516	945	803	1080	1050
CALLS	4319	6147	4942	5789	4453	3883	4613	4437
QSOs	134724	174133	145169	177847	146486	130875	136186	146470

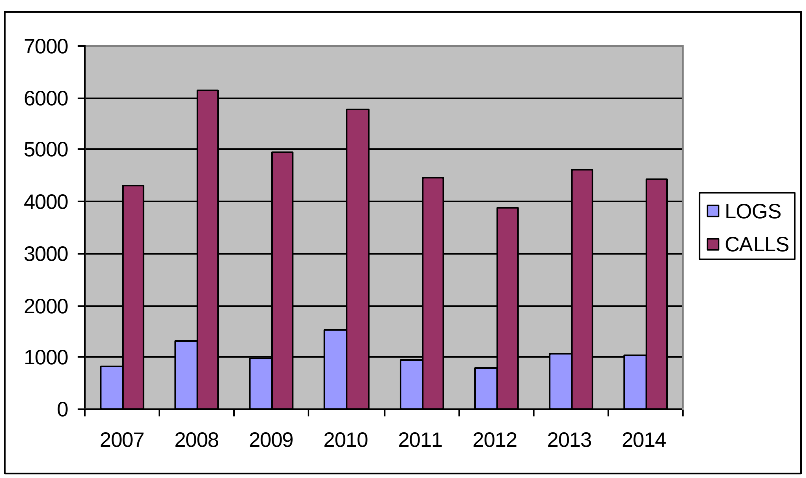
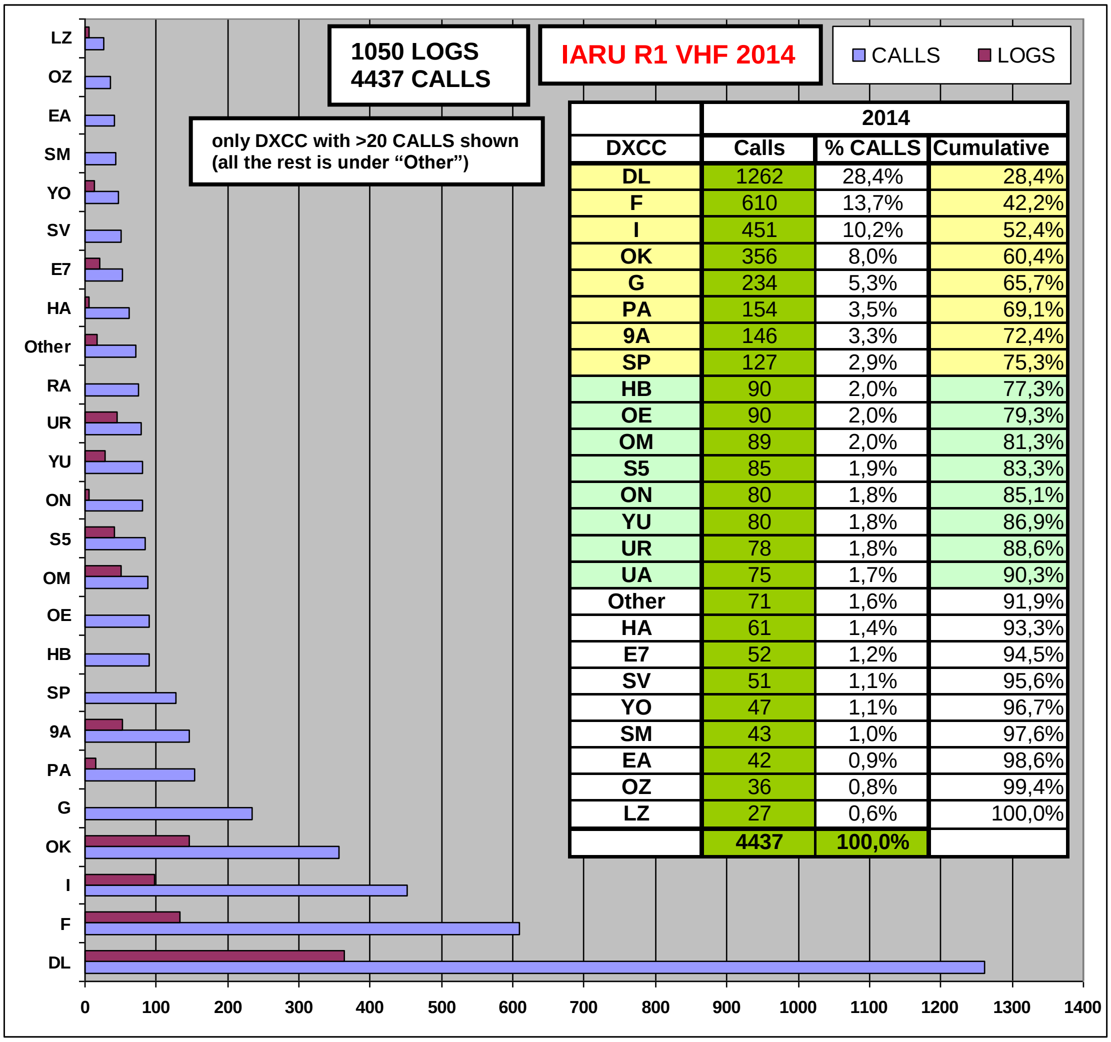
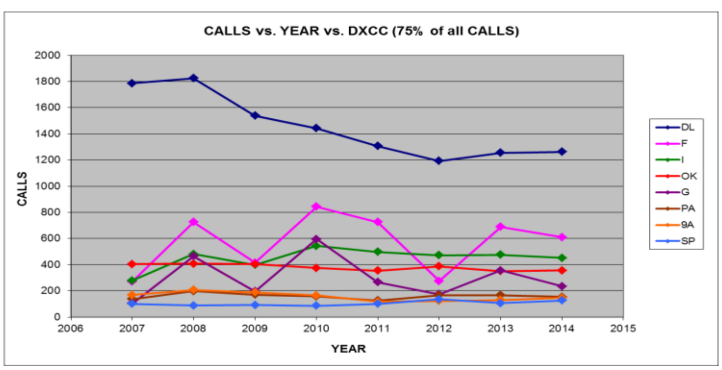


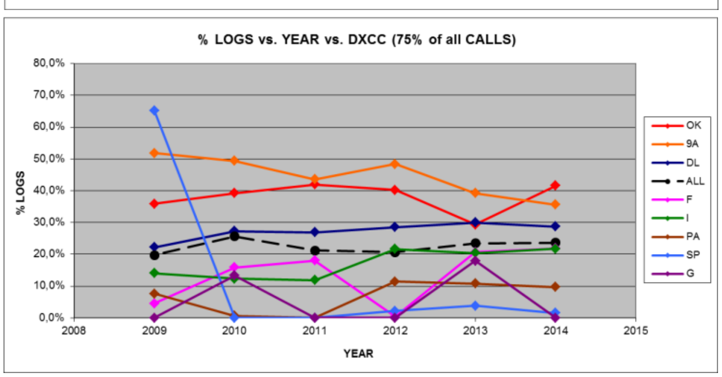
Figure ***1*** shows breakdown of participants and logs from different countries for 2014 contest. As it can be seen, **DL hams represent more than a quarter of all participants**. Participants from the first 8 countries represent 75% of all contesters (and yes, 75% of all licensed amateurs in EU come from the same 8 countries). Complete breakdown for all 8 years is provided in the Appendix.



DXCC	2014 Calls	% CALLS	Cumulative
DL	1262	28,4%	28,4%
F	610	13,7%	42,2%
I	451	10,2%	52,4%
OK	356	8,0%	60,4%
G	234	5,3%	65,7%
PA	154	3,5%	69,1%
9A	146	3,3%	72,4%
SP	127	2,9%	75,3%
HB	90	2,0%	77,3%
OE	90	2,0%	79,3%
OM	89	2,0%	81,3%
S5	85	1,9%	83,3%
ON	80	1,8%	85,1%
YU	80	1,8%	86,9%
UR	78	1,8%	88,6%
UA	75	1,7%	90,3%
Other	71	1,6%	91,9%
HA	61	1,4%	93,3%
E7	52	1,2%	94,5%
SV	51	1,1%	95,6%
YO	47	1,1%	96,7%
SM	43	1,0%	97,6%
EA	42	0,9%	98,6%
OZ	36	0,8%	99,4%
LZ	27	0,6%	100,0%
	4437	100,0%	

Figure 1: number of participants and logs from different countries for IARU R1 VHF 2014

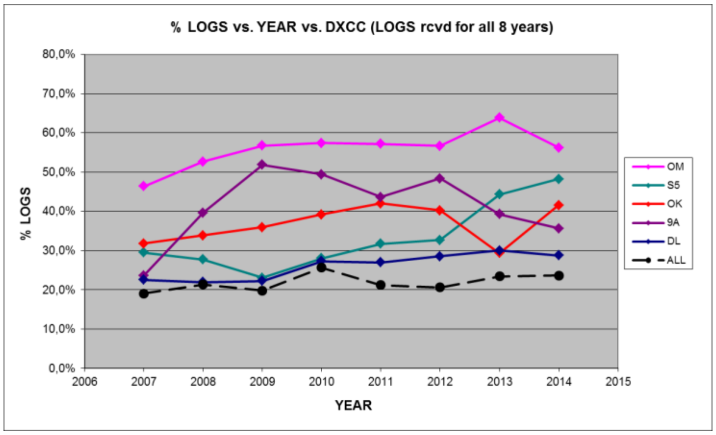




We were interested to see activity trends first. **As it can be seen the trend is negative, as expected.** The most dramatic fall in number of participants is seen for DL, 30% over those 8 years. Funny zig-zag trend line for F and G is because no logs were available for some years. The picture gets clearer if we look into the graph showing % of received logs over time. Not surprisingly, when there are no logs at hand from certain country then also the number of different call signs gets lower. Activity trend graphs for other EU countries are presented in the Appendix.

There were logs available for all 8 years from 5 countries only! **Does this mean that only VHF managers from DL, OK, OM, 9A and S5 "feel" some responsibility to their ham community?** Or does this fact reflect a decade long saga of setting up central IARU R1 contest server web site? Equivalency to CQ WW DX contest fails in this respect big time – to my thinking, this due to the fact that IARU R1 organization did not establish "contest manager" position (having a single person responsible and accountable for VHF&up contest organization).

The % of logs received versus all call signs can be interpreted as the level of "respect" contesters have toward the contest and contest organizer(s). **The OM 2m operators**



clearly lead in this respect as almost 2/3 of all OM participants regularly sent the log. Anyway, the EU average is between 20% and 25%, and was more or less constant over the last 8 years. For sure there are methods to increase the % of logs sent (for example, s51fb, S5 VHF Manager, for last few years, posts very polite announcement two weeks before the contest start with an appeal to send the log no matter how many QSOs were made; as it can be seen from the S5 trend line this method obviously works ☺).

3. Contest history

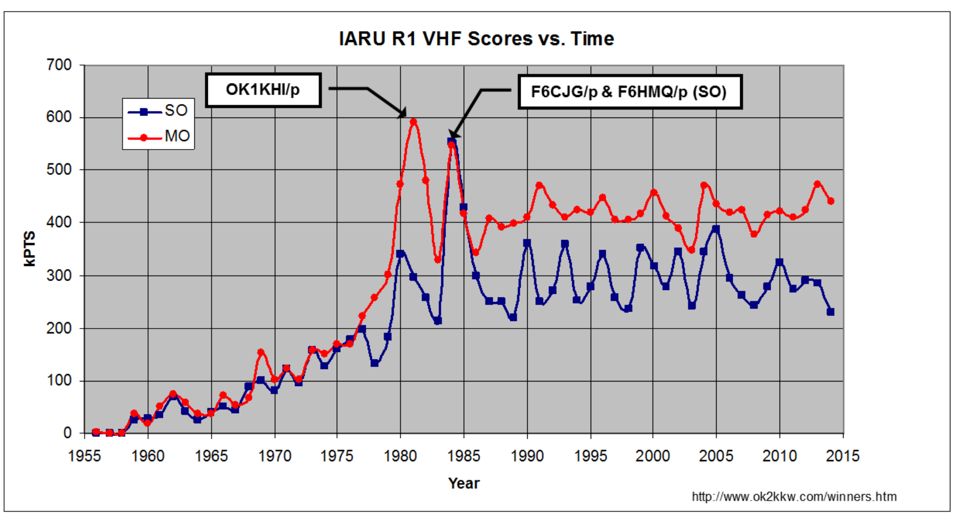
The IARU R1 VHF contest has almost **60 years long history**. The first event was held back in **1956**. The graph below shows winner's score for SO and MO category over those years. This graph reveals at least two striking facts; first, the highest ever score was made back in 1981 by OK1KHI/p, and second, the average result from 1985 on is more or less constant. There were only 4 stations in the whole contest history that crossed half a million points, namely OK1KHI/p and OE5XXL/2 (as 2nd place) in 1981, F6CJG/p and F6HMQ/p (SO) in 1984.

And then, if we focus on MO only, **the average winner's result from 1985 till today is 418k points**. With 3x standard deviation of 90k one can conclude that it will be very hard to cross 500k limit again.

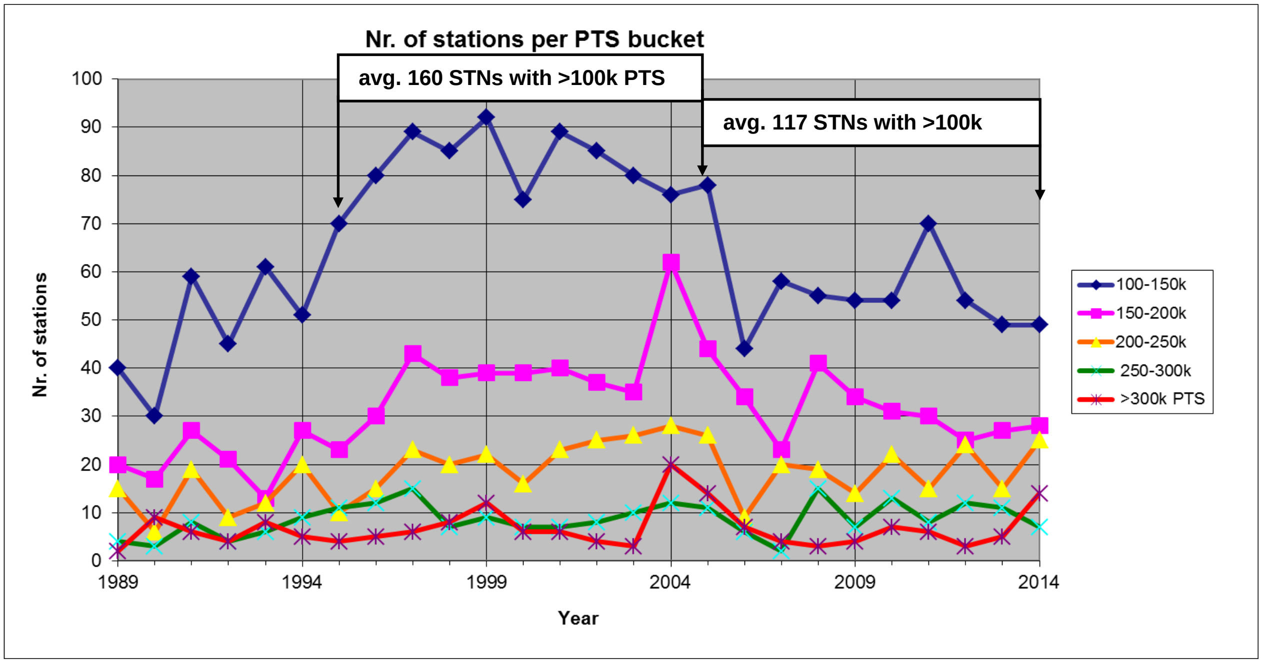
Many questions arise, but two are most prominent:

- **how come the average winning score is constant while the activity trend is negative**
- **what exactly happened in 1981 and 1984?**

The OK1KHI/p story is well documented on the OK2KKW web page. In short, although operating with really modest equipment for today standards (two antenna systems with single 10 el. and 7 el. yagi; 80W on first system and the second was for RX only due to broken PA), OK1KHI/p benefited from extremely good propagation conditions. During all 24h of the contest they had ducting conditions toward 800-1000 km distant regions with very high activity. Unfortunately there is no data available about the conditions in 1984, but it must have been something similar. The fact that nothing similar happened in the last 30 years could be explained; obviously the probability of having properly thick duct layer AND over the right area AND at the right altitude AND during the full first weekend of September **must be very low**. We all know there were ducting conditions available now and then (in 2013, for example), but not over the optimal area and not for long enough time.

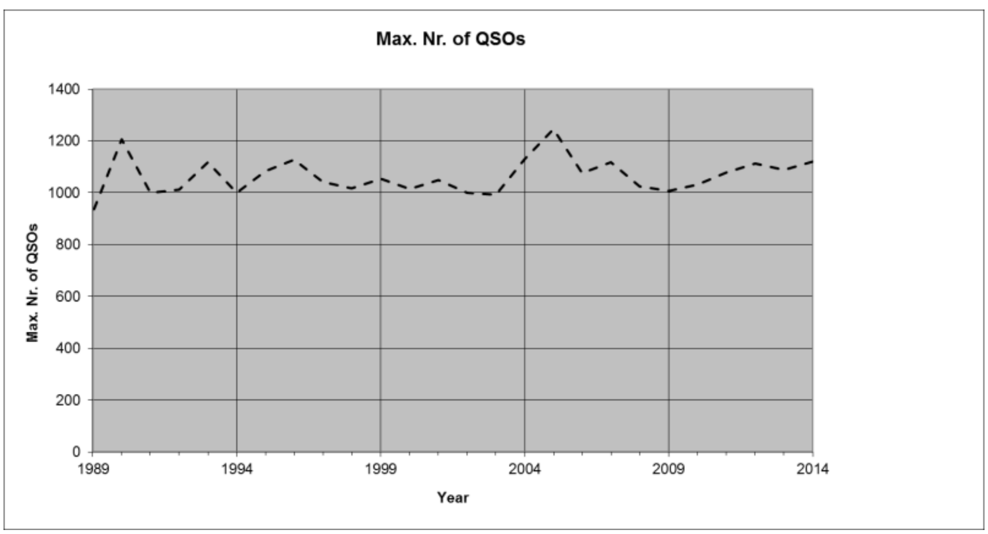


The first question, namely how come that the best result is constant while the activity is going down, is trickier to answer. This article will try to give better insight into the matter and discuss various factors that can be (are?) limiting maximum achievable score. Active contesters mostly blame negative activity trends for not scoring higher. But how much truth is in this statement? Unfortunately we do not have logs back to 1985 (not even back to 2006 ☹), but we have final results from 1989 on. So I used this data to present an **indication of activity** during those times. The graph below shows how many stations scored within a given points bucket, i.e. how may stations scored more than 300k points, how many from 250k to 300k, and so on. As it can be seen, **the number of stations that made more than 200k points is more or less constant** which is somehow expected when looking to the graph showing best score over the years. Now the number of stations that scored between 100k points and 200k point should give good indication on the overall activity level.



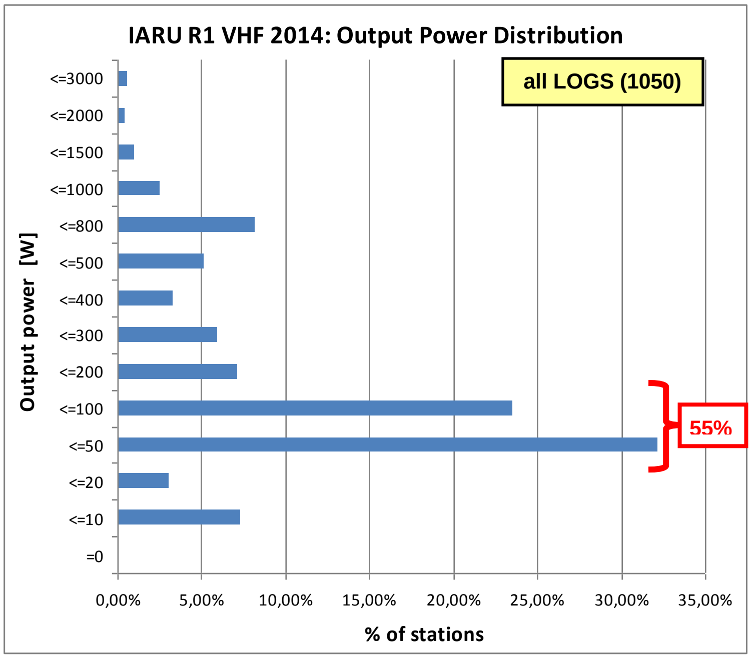
Three time slots can be identified:

- 1989 – 1994: the activity looks low even though the winner's score was "normal" (i.e. above 400k); we can speculate that the number of logs received was very low those years
- 1995 – 2005: there was an obvious peak in activity with 160 stations scoring above 100k points in average (MO and SO combined); during that time best score was as "normal" as before ☹
- 2006 – 2014: the average number of stations scoring above 100k dropped by 27%, while the best result is still at the "normal" level

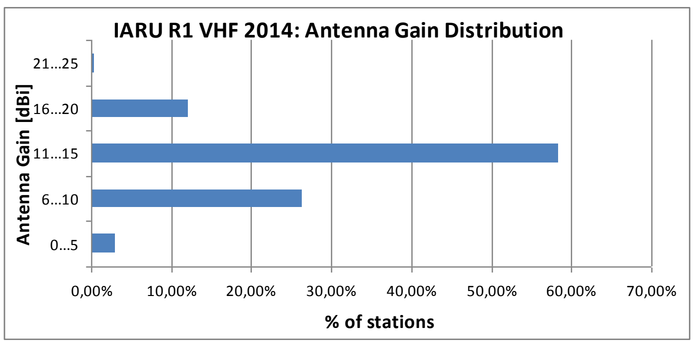


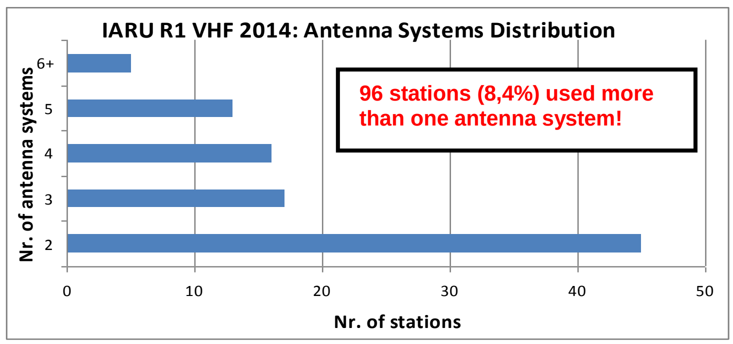
There was an interesting peak in 2004; we had no intention to search for the reasons behind, although it would be very interesting to get and analyze some data. Looking at the graph of maximum number of QSOs made (not necessary by the winning station) also reveals an interesting insight. **It seems like there was never too hard to make 1000 QSOs** (at least for few big guns, hi) and **that there is a hard limit at around 1300 QSOs**. I will try to explain this later in the article.

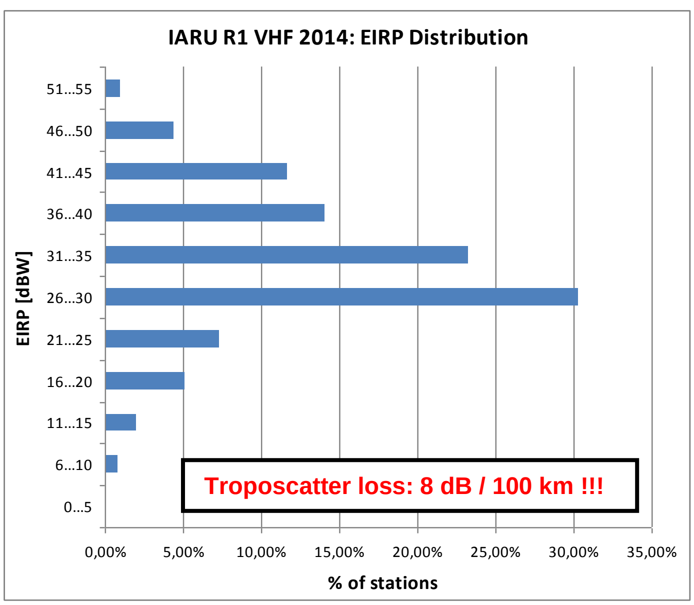
4. What equipment are we using today



Such a large set of logs with "summary sheet" data can form an excellent base for some interesting distribution charts never done before. Like, what is the distribution of output power, antenna gain and EIRP? It is encouraging to see (from a big gun's point of view) that **more than half of all participants transmit with 50 to 100 watts**. For sure the distribution peak was lower 20 years back, may be as much as 10 dB lower. The antenna gain distribution also uncovers important information that 70% of all stations use antenna with 11 dBi of gain or more. I do not believe the antenna gain distribution was much different 20 years back (maybe 3 dB lower or so). And finding out that almost 10% of stations that sent the log (**96 big guns**) were operating 2 antenna systems or more (**DK0A holds the record with 7 antenna systems**) is also insightful. To estimate average idealistic maximum QRB one needs to look at EIRP distribution, as the link budget is governed by EIRP, RX antenna gain and RX NF. RX NF should be at its low limit for most of the stations so no special attention was given to it.







73% of stations with > 26 dBW EIRP!

26 dBW examples:

100W + HB9CV

50W + 4el. yagi

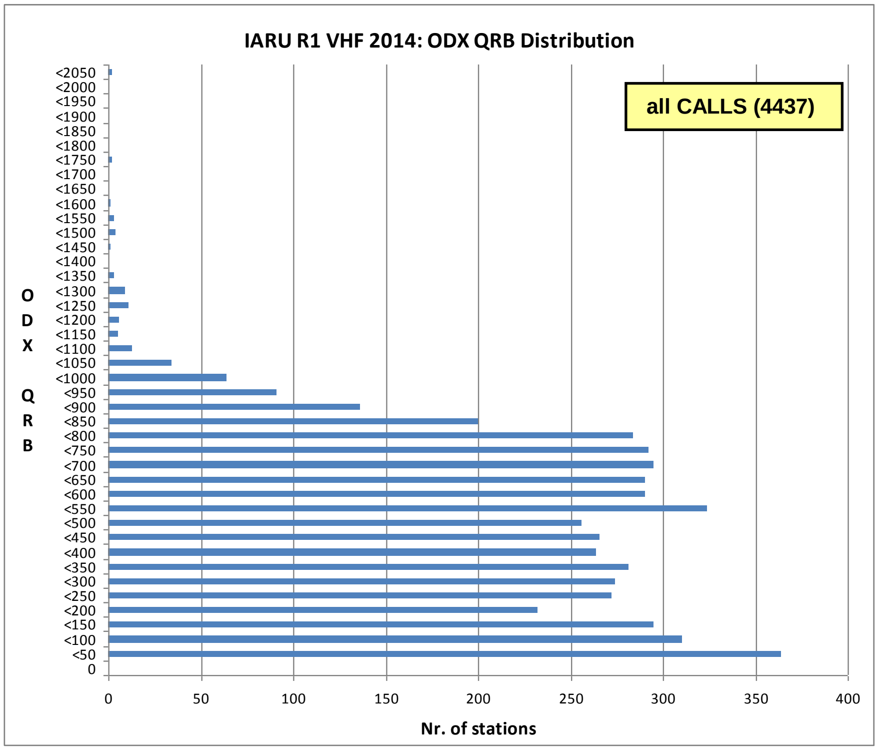
10W + 8m boom yagi

26 dBW TX EIRP

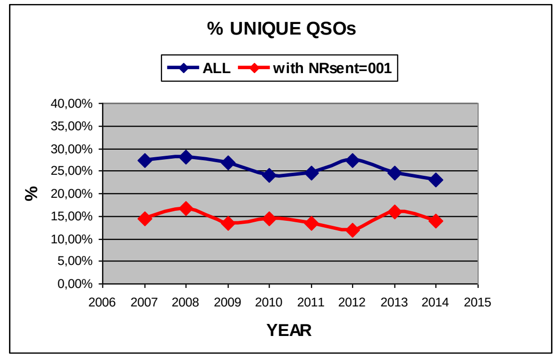
+ 11 dBi RX antenna gain

= 500 km QSO (open horizont)

Convolving distributions of EIRP and antenna gain one would expect to see ODX QRB distribution having a peak at around 500 km (EIRP peak at 26 dBW + antenna gain peak at 11 dBi = 500km range with open horizon at both ends). The actual ODX QRB distribution is really shocking, **namely it is almost flat from 50 km to 800 km** (peak is actually at 50 km ☺). How come? It turns out that one of the reasons is high number of unique calls. On average, every year, **about 15% of participants made just a single QSO**!



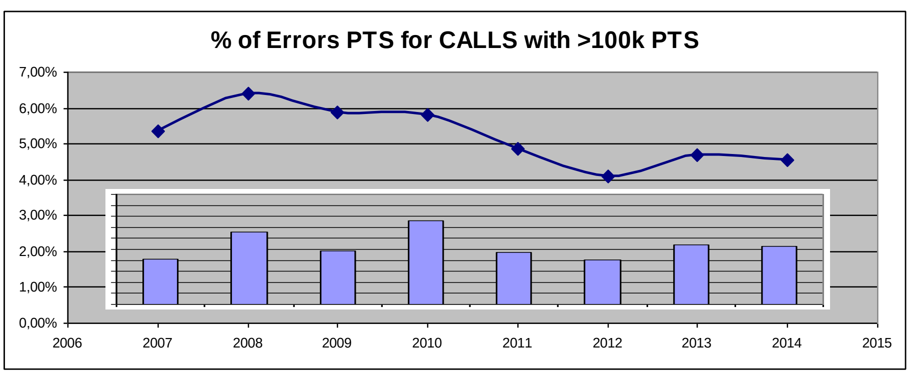
I hear voices stating that those call signs are faulty (receiving error) or that were logged without actually being worked (fraudulence). I frankly believe those QSOs were really made on the band – it looks like a standard practice that some stations (666 in 2014 contest!) **would only give points to their friend or club station**.

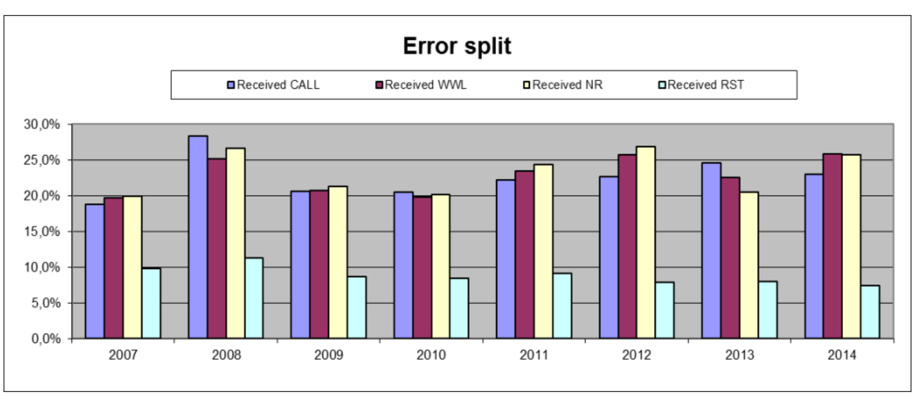


Number of all unique call signs (also those with sent NR of 2 or more) is strikingly high. Some of those call signs are really erroneous, but most of them are truly unique. Breakout of unique call signs per DXCC shows that they come from all parts of EU (and not just from the periphery, which would easily explain the phenomenon). What is the motivation of a station from let say middle of DL (just as an example), to make just one QSO (with QRB of over 400 km)? **Operating ham radio contest should reflect general ham radio spirit**, to my mind, which means that you try to make as much QSOs as you can during the time you have decided to spent on the band.

5. Error statistics

We were interested to see whether ever more rigor contest log cross checking has some influence on the operator skills. At first it looked like the average % of errors is decreasing over time, but when correlating the data with number of logs available, we can conclude **that the % of errors is more or less constant at 5% to 6%** (only logs with >100k points were counted here to represent "serious" contesters). I just cannot believe this is the bottom limit for VHF contest!? There must be ways to improve the operator skills to complete the QSO (6% at 200k is 12k points, which is 40 average QRB QSOs – really a lot). Breakdown of errors also sheds a light into what meaningful data is actually transferred during the VHF contest QSO. Many are stating that only call sign and QSO number are the relevant data, as report is always 59 and UL comes from the database. It turns out that this is not so, as all 3 main sets of data (call sign, NR and UL) share the same % of errors. I am pleased to see that RST is not going HF contests way (yet).

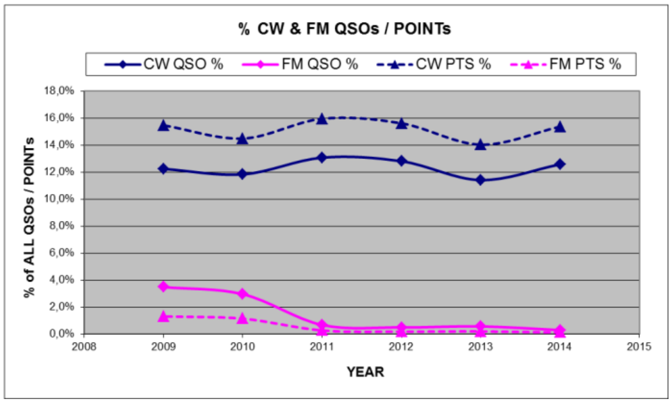


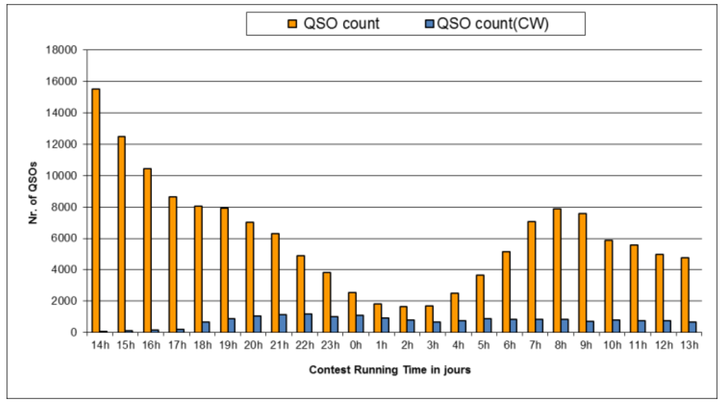


Comparison of the number of data pieces exchanged during the contest QSO between IARU R1 VHF and CQ WW DX shows that at least 3 times more data needs to be exchanged in the VHF contest. This ratio then governs the maximum QSO rate to be around 3 times lower at VHF. **The maximum achievable QSO rate is one of the barriers that limits number of QSOs in VHF IARU R1 contest!**

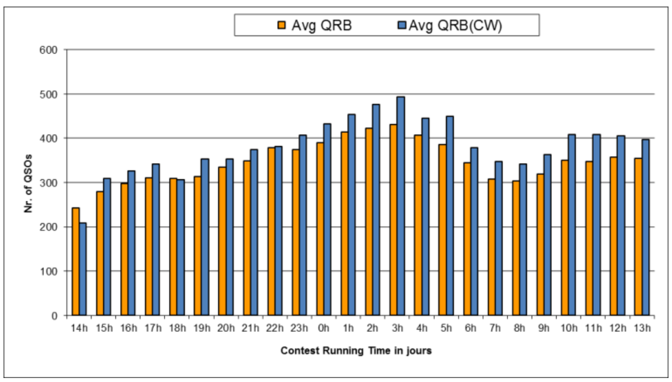
6. SSB vs. CW

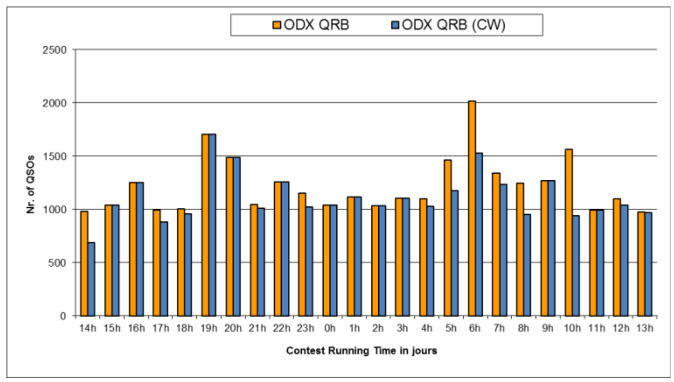
Inspecting the logs of top ranked stations reveals an interesting view that they do not use CW much. And true, **only about 12% of all QSOs were made in CW** (15% of points). The CW operation begins **5 hours after the contest start** and has a steady rate of about 1000 QSOs per hour.





Average QRB in CW was higher than in SSB – as expected. The difference in average QRB starts to be seen only after the midnight. On the other hand, ODX QRB QSO in each running hour was always made in SSB!?





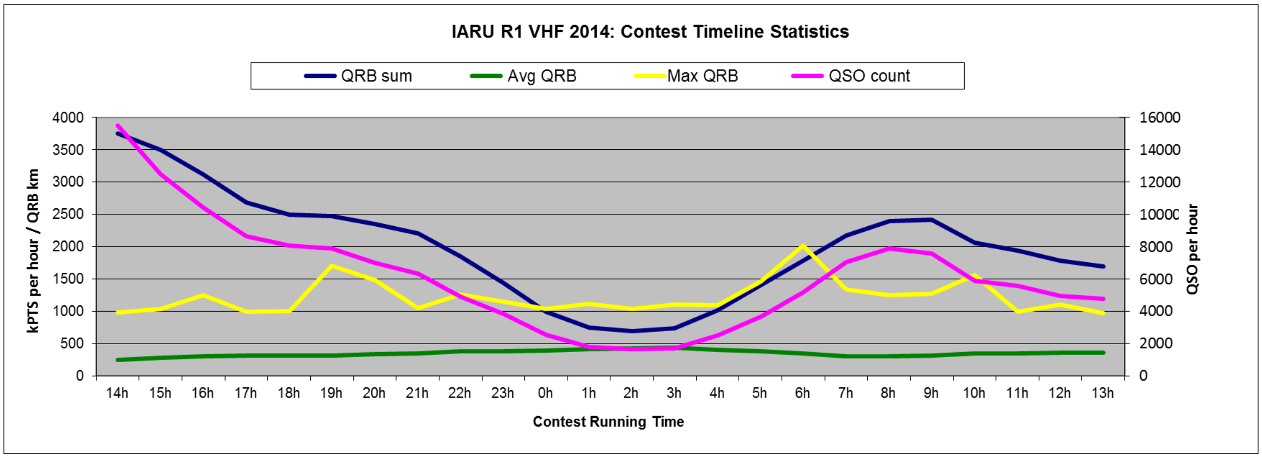
The CW vs. SSB QSO/points ratio does not reflect 144 MHz band plan regulation. Namely, **60%** of all channels available are dedicated to CW mode, while only **15%** of all contest points (km sum) are realized in CW. For the illustration purposes used channel bandwidths of 1 kHz and 3 kHz should be OK (we can have a debate on the number of available SSB and CW channels during the contest somewhere else).

125 working channels (1kHz CH BW)	83 working channels (3kHz CH BW)
60% of all (CW+SSB) channels	40% of all (CW+SSB) channels
15% of all points	85% of all points

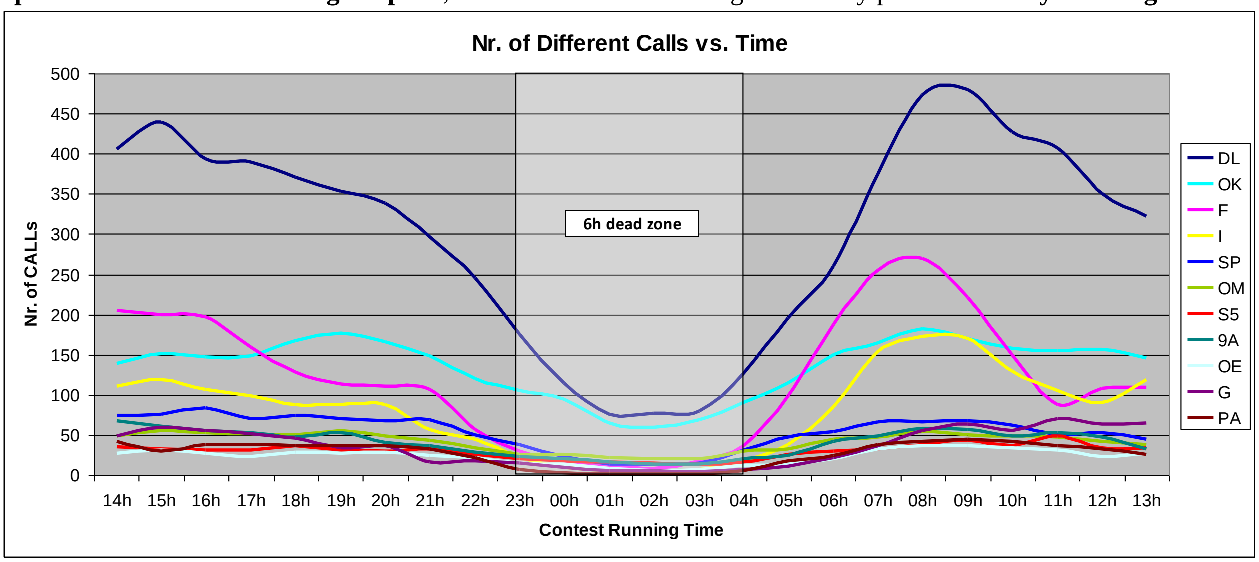
Would a proposal to push the SSB/CW boundary to 144.100 kHz only during the September contest be acceptable?

7. Time line statistics

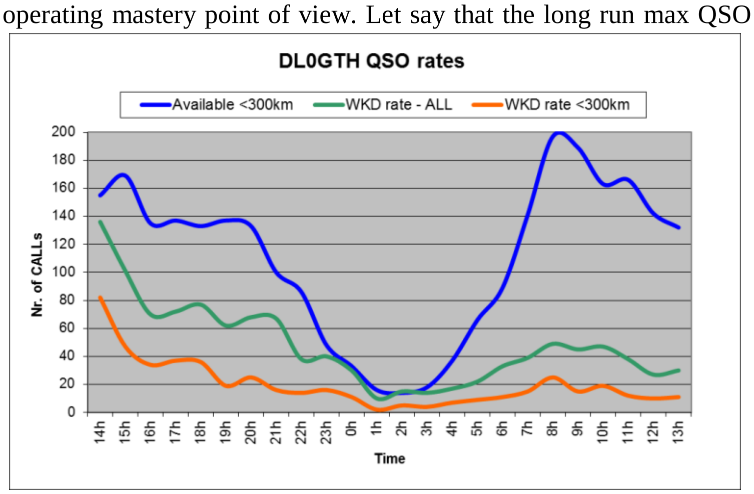
How was the contest "breathing" it can be seen on the graph showing number of QSOs, sum of QRB, average QRB and ODX QRB for every hour of the contest. QSO count significantly drops during the night, while the ODX QRB is stable at approx. 1000 km every hour (disregarding the MS QSOs).



Looking at the time line data for different call signs per DXCC it can be concluded that almost everybody goes to bed, **only DL and OK operators do not bother being sleepless**, hi. It is also worth noticing the activity peak on **Sunday morning**!

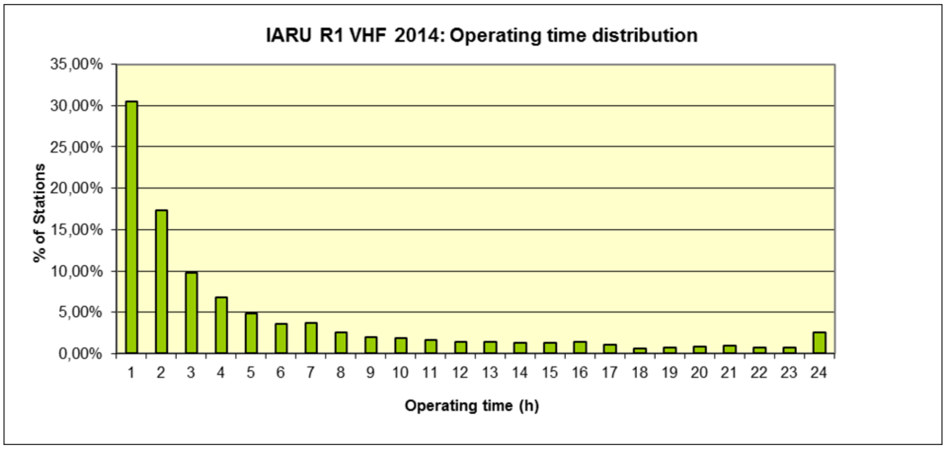


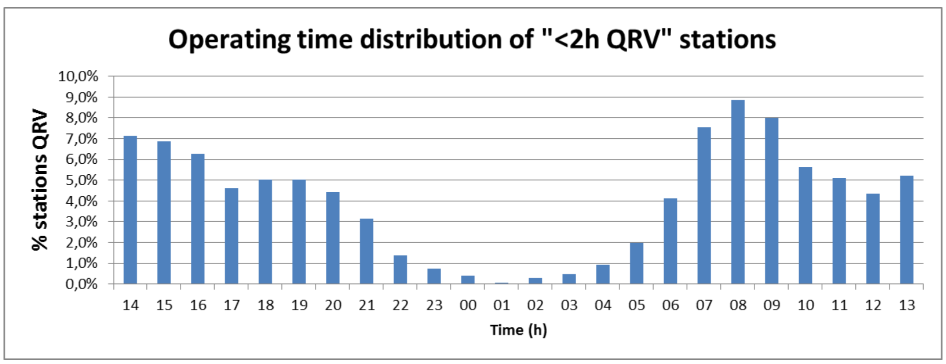
Now, let's try to estimate what would be the maximum achievable number of QSO's in 2014 IARU R1 VHF contest from the operating mastery point of view. Let say that the long run max QSO rate in CQ WW DX contest is 240 QSO/h (for an EU station), then as we explained previously, the max QSO rate in VHF contest would be approximately 3 times less, i.e. around 80 QSO/h. Multiplying by 24h it gives **1920 QSOs**, bit less than double of what was historically achieved. But the 6h dead time during the night is not to neglect, so taking only 18h of full run, we arrive to **1440 QSOs** – still quite far from record QSO count of 1245 QSOs by DL0GTH in 2005. Why so? Let's look at the QSO rate of DL0GTH, a 2014 winner. Graph shows actual QSO rate (green), QSO rate of QSOs with QRB less than 300 km (orange) and a number of different not-worked stations within 300 km radius (blue). We see that DL0GTH started with 136 QSO/h for the first hour (which is an amazing result, by the way); more than 80 QSOs were shorter than 300 km, while there were 150 "local" (<300km) stations still available for a QSO. I choose 300 km QRB as a representative of a "59 QSO", so the signal strength is high enough to run the



pile-up (I acknowledge that for some contest locations or particular directions a 300km QSO can be well below S9 and very hard to complete ☹). We see that DL0GTH were able to maintain a long run QSO rate at around 70 QSO/h (they “run” it till 21h); multiplied by 22h and adding actual first two hours rate, we get to **1770 QSOs**. Now, during the night there were no “local” (<300km QRB) stations available for them – taking this fact into account we find that DL0GTH could theoretically log approx. **1520 QSOs** if they could fill the gap to 70 QSO/h by working available <300 km stations during Sunday. Taking into account interference and that completing >500km QSOs at 70 QSO/h rate is hardly possible my speculation is that it will be very hard to reach 1440 QSOs ever. I take bets ☺

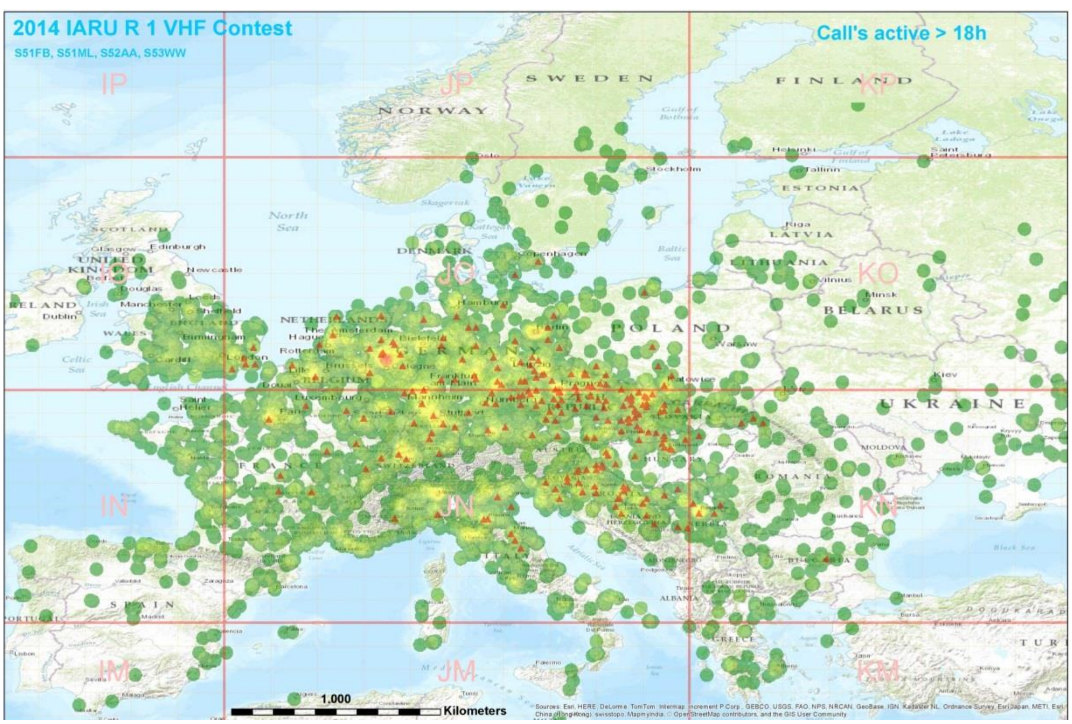
Another interesting statistics is topical after new 6H category is being introduced this year, namely operating time distribution. The distribution, **unique calls not included (!)**, shows that nearly **50%** of participants spend **less than 2 hours** on the band! **And 73% of all stations operate for less than 6 hours.** So the new categories (6H SO and 6H MO) should attract large number of contesters, and more important, **more logs should be received** – let’s see.





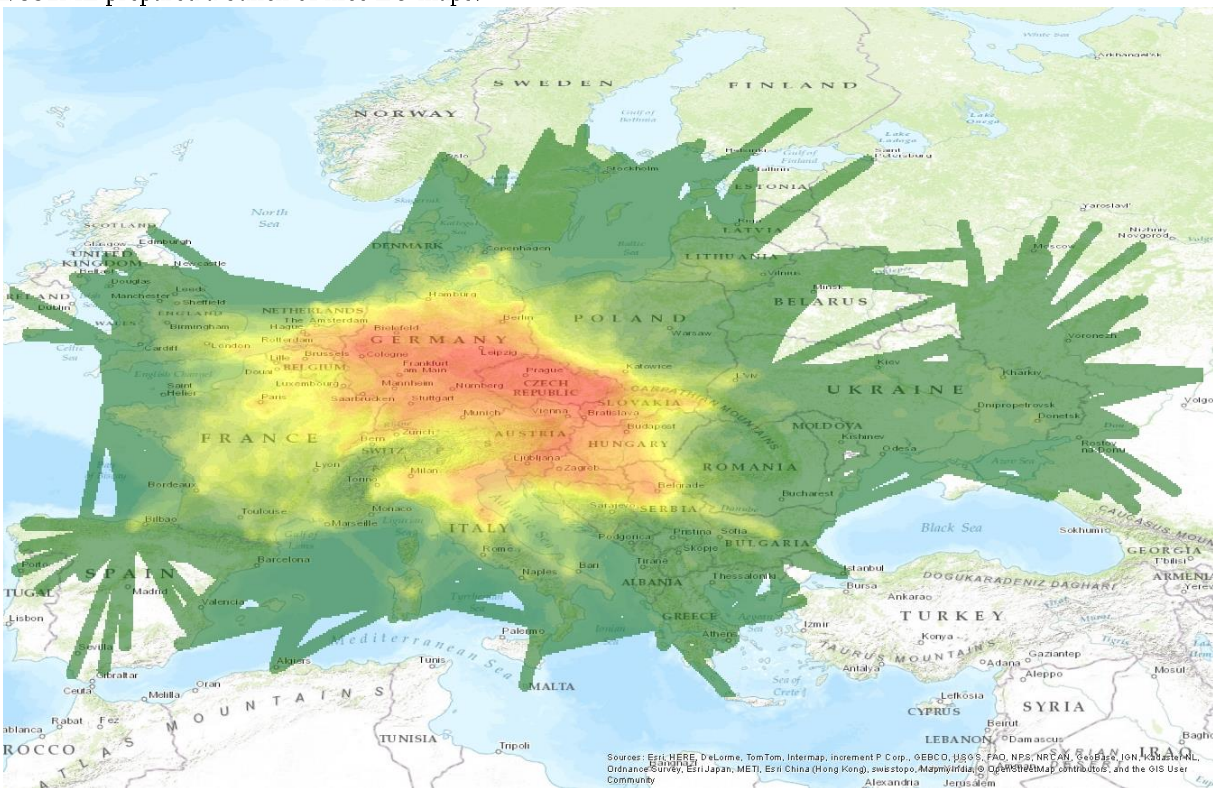
Focusing on the “short lived” stations, the <2h ones, it can be seen that there is no particular time pattern – they are almost evenly distributed during the contest if we neglect the “night black hole”. **This means that big guns should call and listen to all directions all the time**! It is worth noticing that this is and was the strategy of the winning stations for the last 30 years or so.

Map on the bottom of the page shows the locations of the “serious” contesters, the ones that were on the air for 18 hours or more. Most of those operate 2 antenna systems or more. So this map indicates regions **with very high level of QRM**. Clearly OK/OM is a not go-to-contesting destination☹.

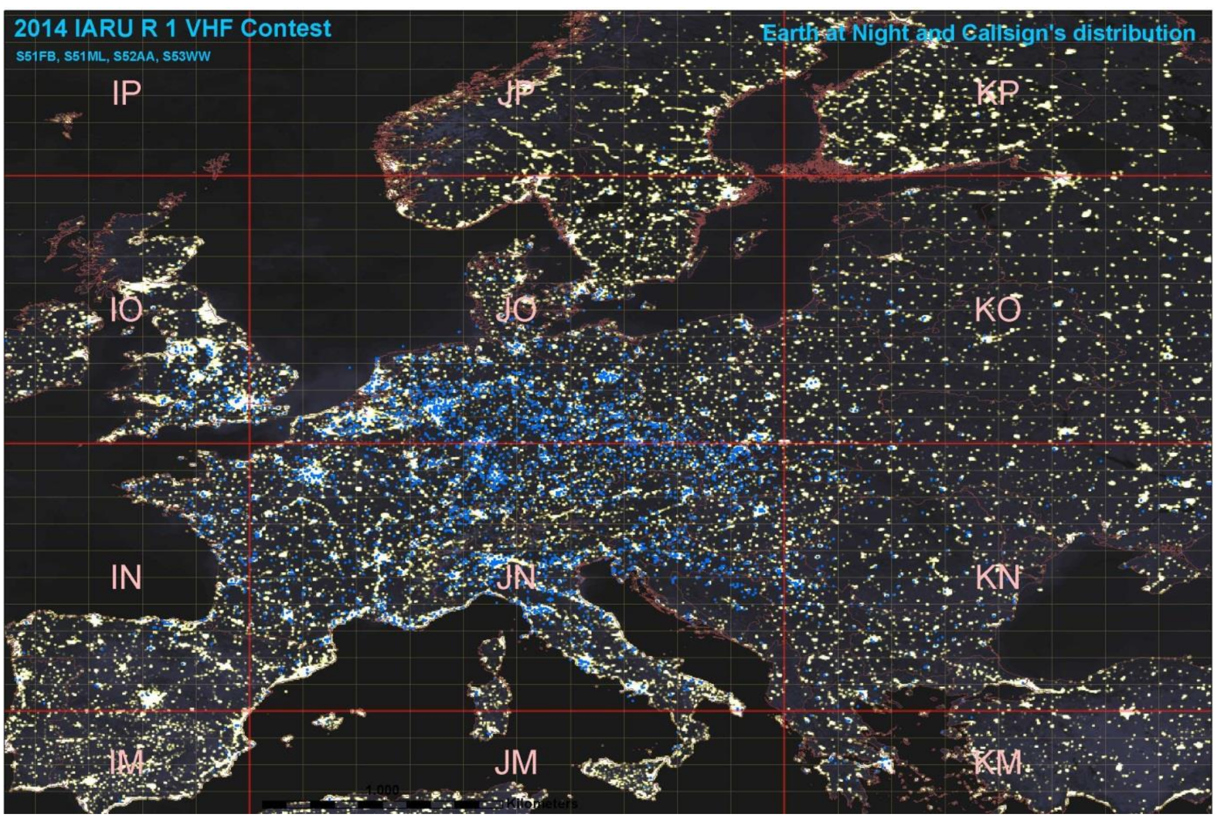


8. Maps

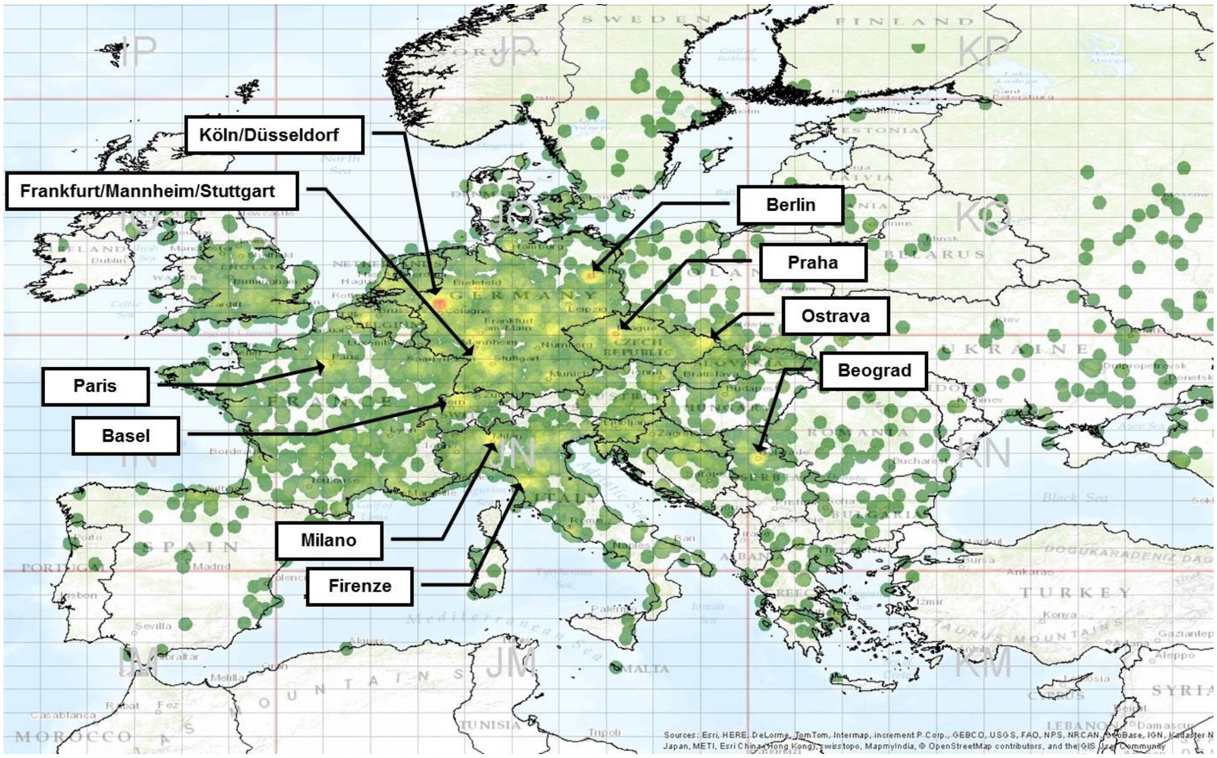
Matjaz/S51ML prepared a bunch of nice EU maps.



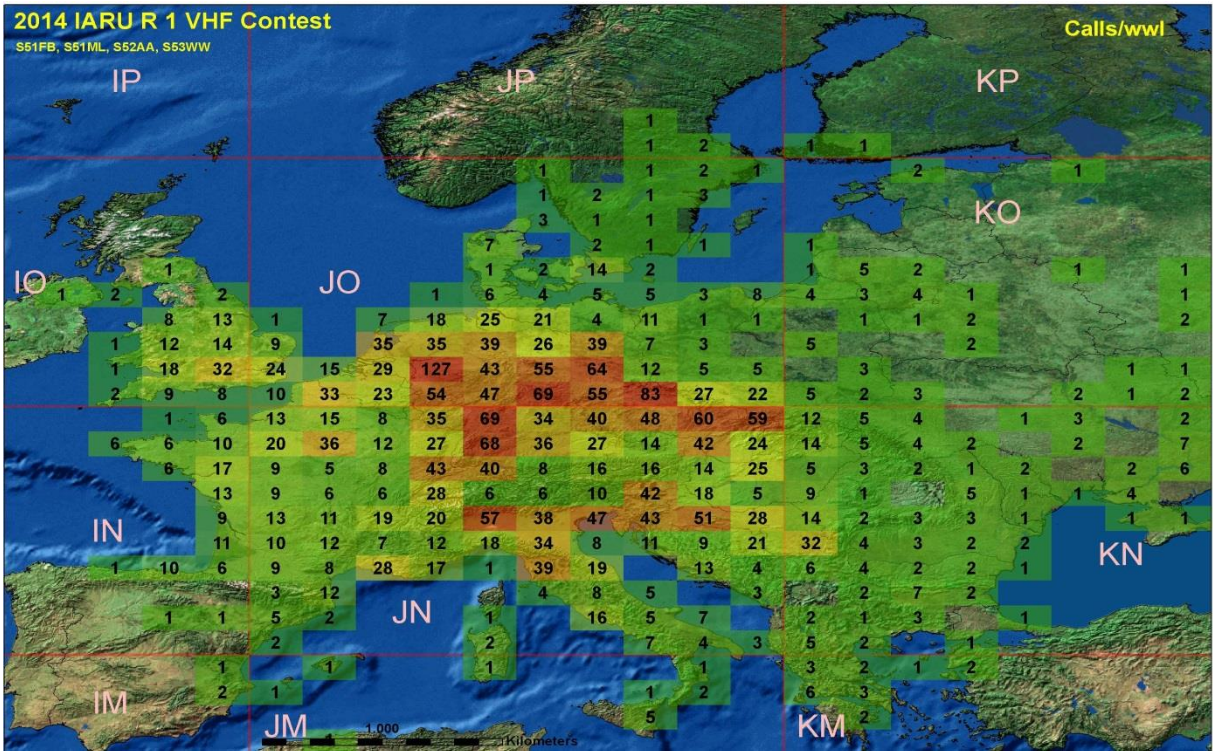
Troposphere “heating” by (ham) radio-activity.



Why some regions with electricity (light) have so low hamradio activity?



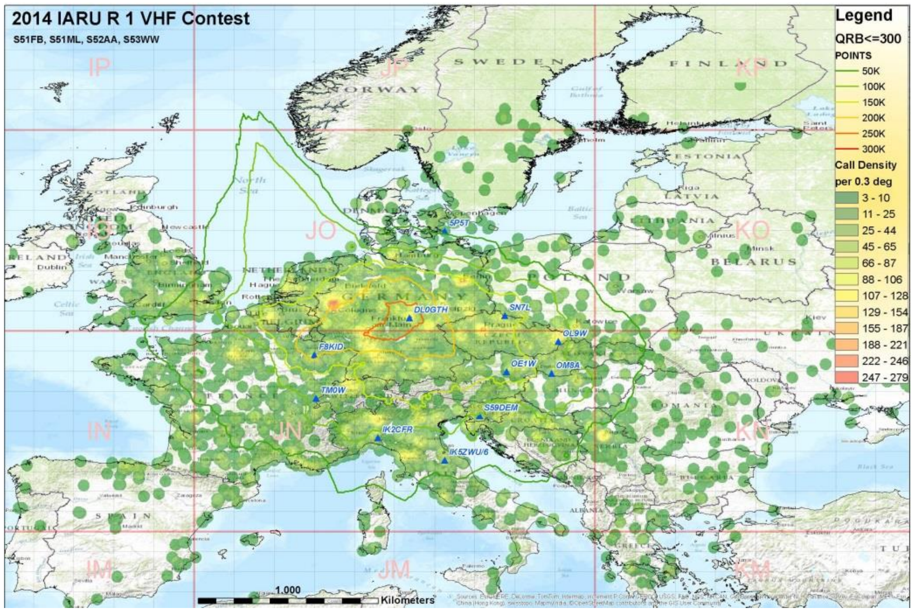
Hot spots are in urban areas - hamradio is a technical hobby…



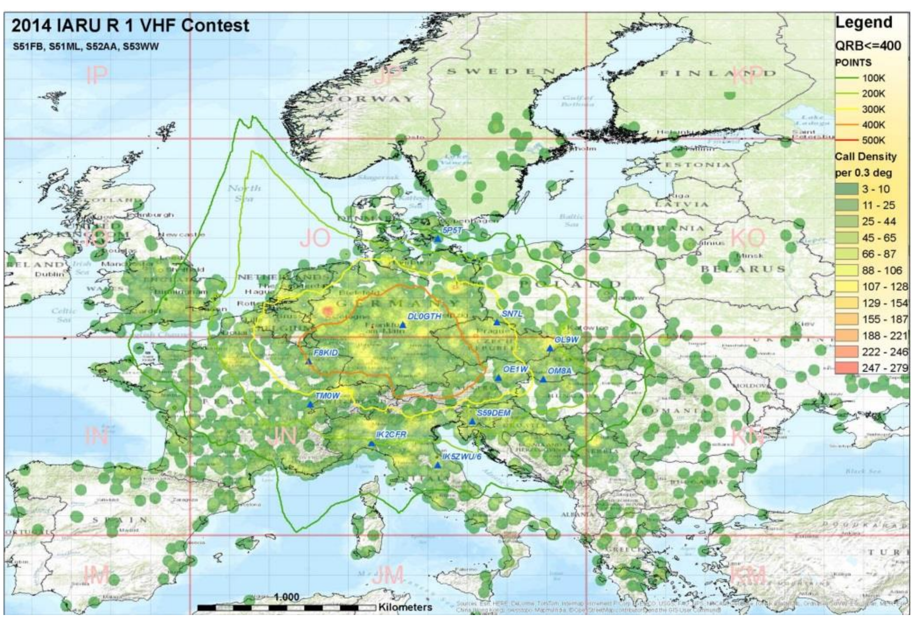
Most wanted squares – note the 127 different stations being active from JO30 square!

9. What if simulation

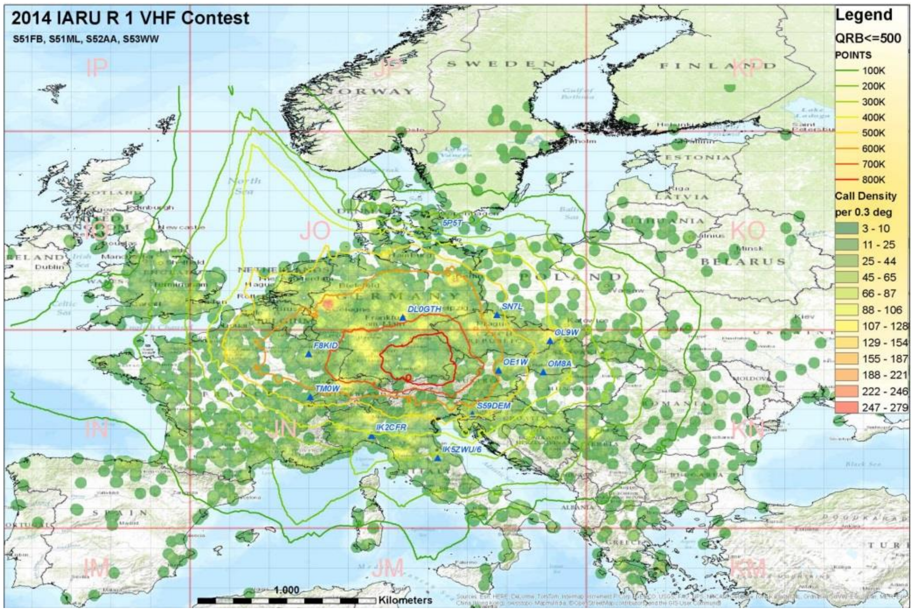
One another idea that came to our mind was to visually present the best contest location based on some **assumptions and simplifications**. Having access to an excellent graphical tool (thanks to s51ml) I came to an idea to create maps with contour lines (I named them IzoQRB lines). IzoQRB is a line that joins all the locations on the map from which the same score would be achieved under the **WRTC style of simplification: all the stations operate the same equipment (antenna gain and height, power, RX NF) and operators have same operating skills.** And the main simplification was that **the earth is flat**, so no mountains or valleys. Of course, all locations share the same propagation conditions. So let's start with equipping the stations with gears that allows them to work all stations within their 300 km radius and nothing more distant than that. The map below shows izoQRB lines for this <300km scenario. Locations of few big gun stations are shown for reference including my club station S59DEM. Unfortunately the scales on the maps are offset, but the contours still provide the wanted information. We can see that DL0GTH is almost at the best position for this scenario, and if they could work all the stations that were active in this contest and were closer than 300 km, they would score a bit more than **165k points / 850 QSOs**!



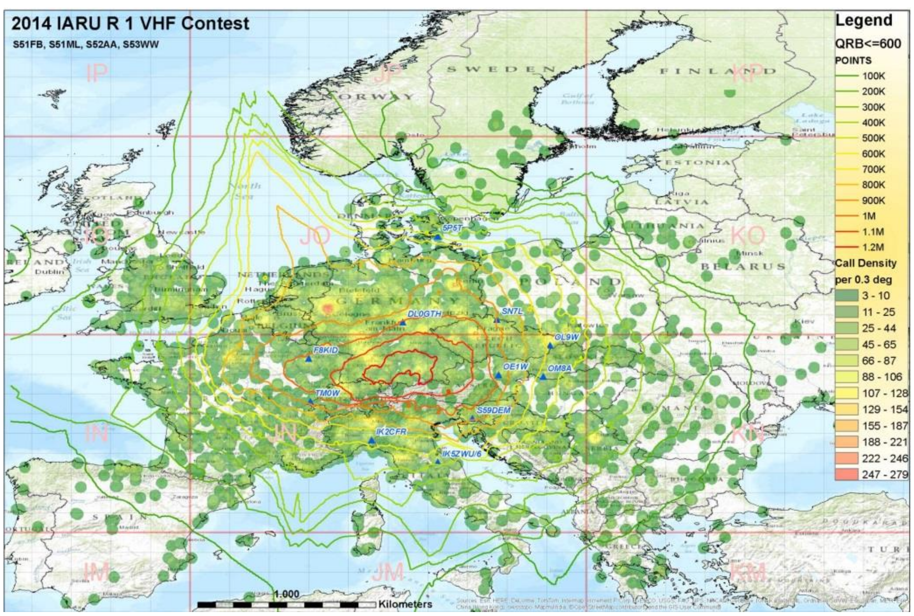
Now we increase the power to all stations by 8 dB (i.e. letting them work 400 km stations) and we get the <400km izoQRB map. **The red dot in the JO40 square is DA0FF** – they would score 270k points if they would only be able to work all the <400km stations (1161 QSOs) that were active in this contest!



So let’s continue. The <500km izoQRB map shows that **THE location** could be Zugspitze (a 2962m high peak on the DL/OE border).



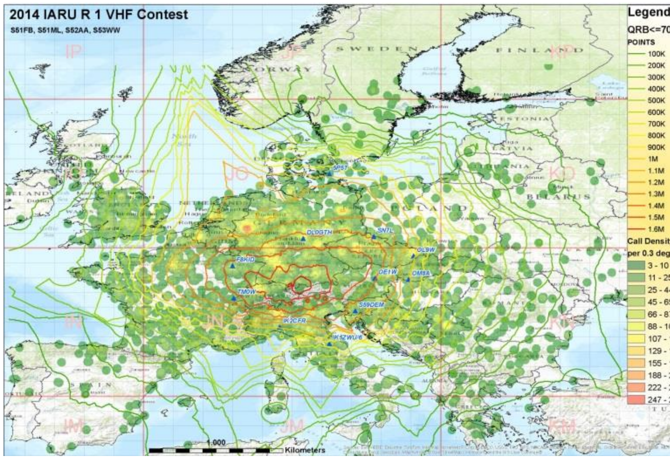
The <600km izoQRB map shows that the best location is still north of Alps.

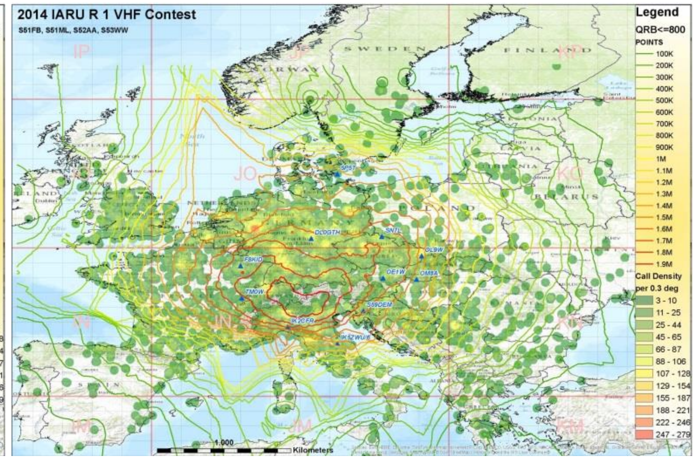


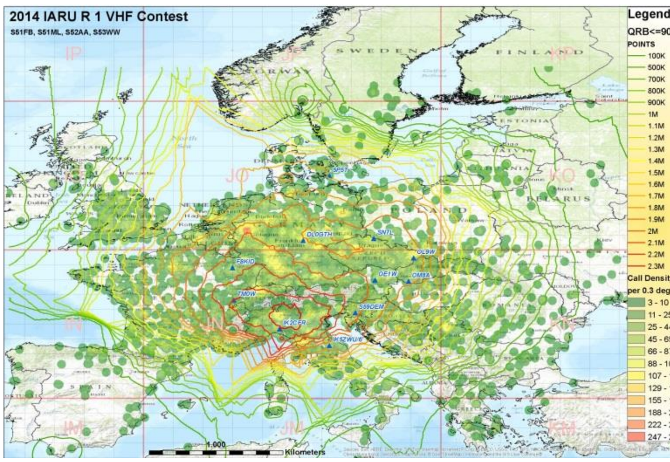
The other izoQRB maps are presented below just to show that **actually the best location is Monte Carlo** (everybody knows that already☺).

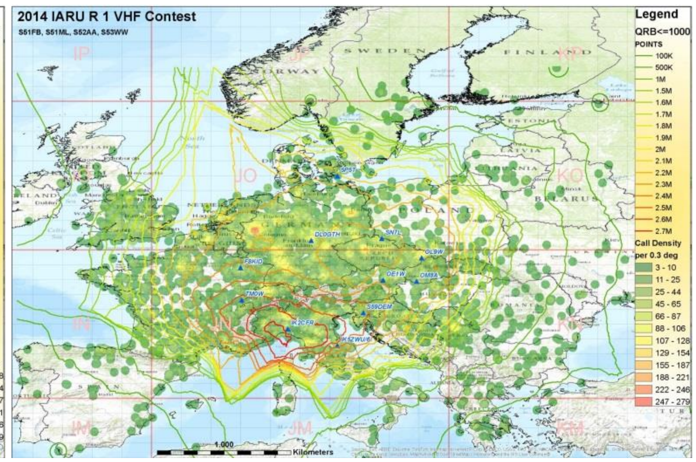
As we are not economists, we will take those maps rather for fun than for really planning the next contest expedition to 3A.

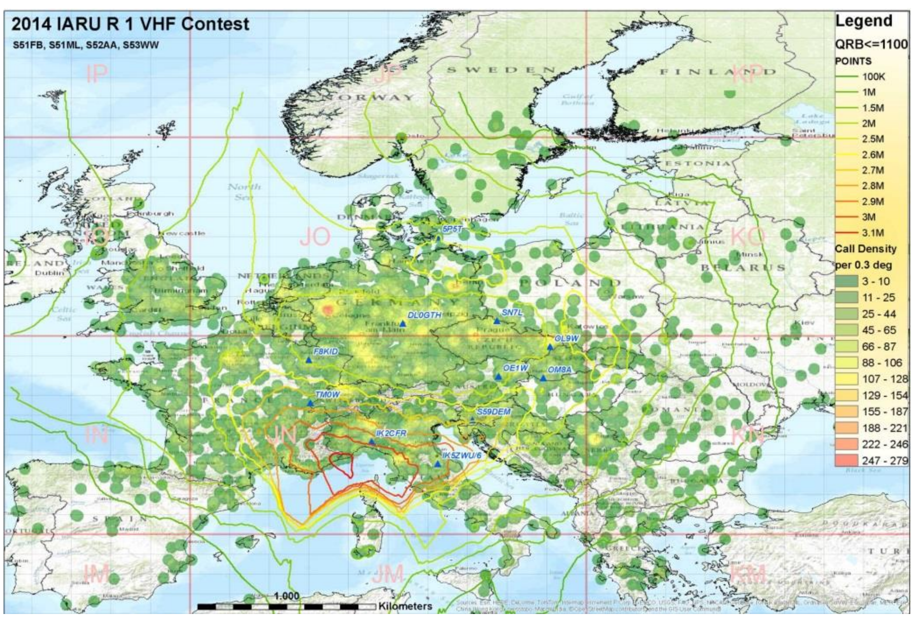
Never the less, I still believe that izoQRB maps for 300/400/500km hold some valuable information (at least to the North-of-Alps contesters).


2014 IARU R 1 VHF Contest
S51FB, S51ML, S52AA, S53WW
Legend
QRB<=700
POINTS
100K
200K
300K
400K
500K
600K
700K
800K
900K
1M
1.1M
1.2M
1.3M
1.4M
1.5M
1.6M
Call Density
per 0.3 deg
3 - 10
11 - 25
25 - 44
45 - 65
66 - 87
88 - 106
107 - 128
129 - 154
155 - 187
188 - 221
222 - 246
247 - 279
1.000
Kilometers


2014 IARU R 1 VHF Contest
S51FB, S51ML, S52AA, S53WW
Legend
QRB<=800
POINTS
100K
200K
300K
400K
500K
600K
700K
800K
900K
1M
1.1M
1.2M
1.3M
1.4M
1.5M
1.6M
1.7M
1.8M
1.9M
Call Density
per 0.3 deg
3 - 10
11 - 25
25 - 44
45 - 65
66 - 87
88 - 106
107 - 128
129 - 154
155 - 187
188 - 221
222 - 246
247 - 279
1.000
Kilometers

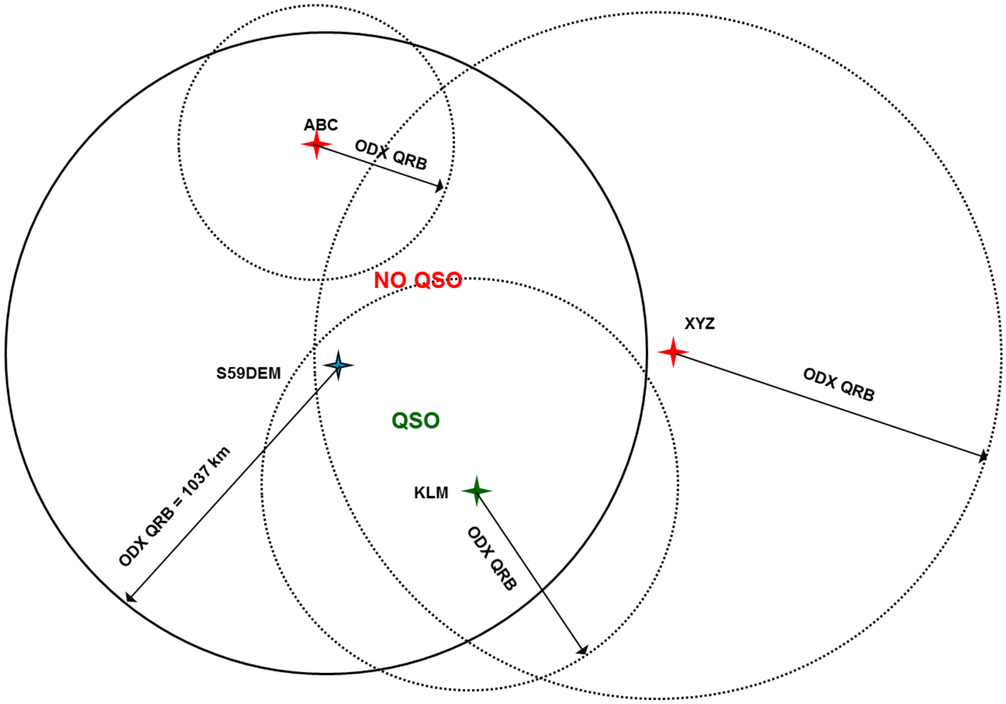

2014 IARU R 1 VHF Contest
S51FB, S51ML, S52AA, S53WW
Legend
QRB<=900
POINTS
100K
500K
700K
800K
900K
1M
1.1M
1.2M
1.3M
1.4M
1.5M
1.6M
1.7M
1.8M
1.9M
2M
2.1M
2.2M
2.3M
Call Density
per 0.3 deg
3 - 10
11 - 25
25 - 44
45 - 65
66 - 87
88 - 106
107 - 128
129 - 154
155 - 187
188 - 221
222 - 246
247 - 279
1.000
Kilometers


2014 IARU R 1 VHF Contest
S51FB, S51ML, S52AA, S53WW
Legend
QRB<=1000
POINTS
100K
500K
1M
1.5M
1.6M
1.7M
1.8M
1.9M
2M
2.1M
2.2M
2.3M
2.4M
2.5M
2.6M
2.7M
Call Density
per 0.3 deg
3 - 10
11 - 25
25 - 44
45 - 65
66 - 87
88 - 106
107 - 128
129 - 154
155 - 187
188 - 221
222 - 246
247 - 279
1.000
Kilometers

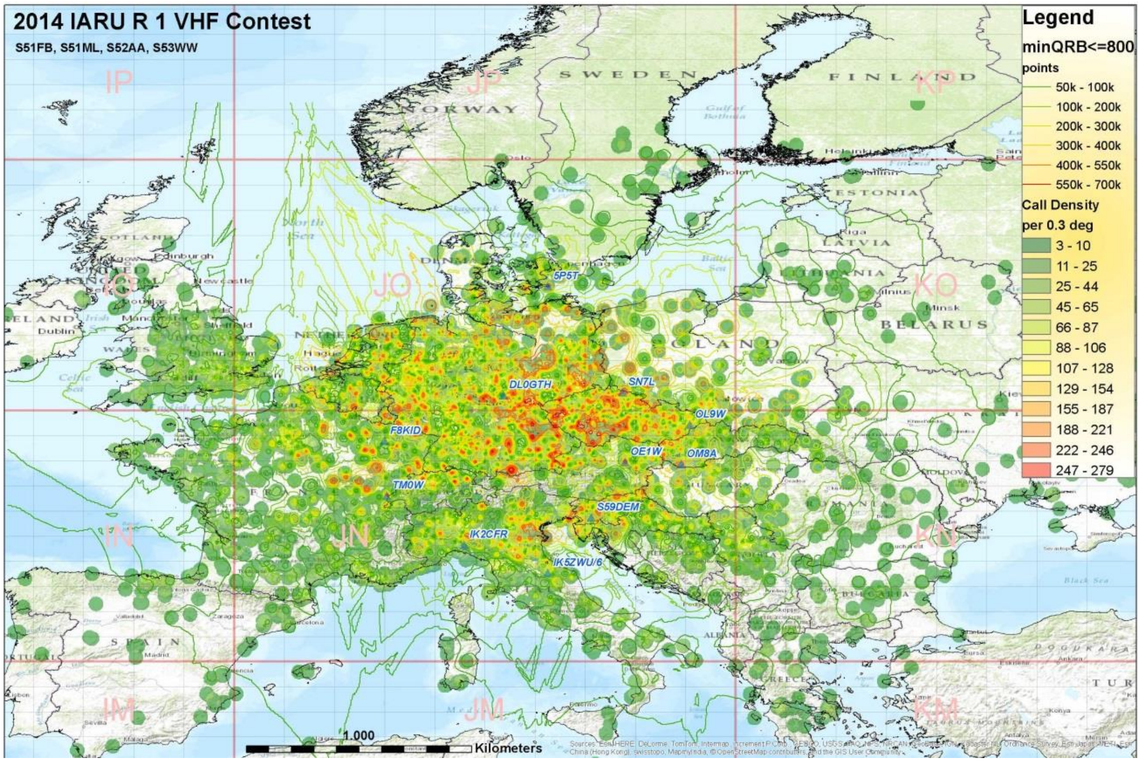

2014 IARU R 1 VHF Contest
S51FB, S51ML, S52AA, S53WW
IP
JP
KP
JO
KO
IN
JN
KN
IM
JM
KM
SP5T
DL0GTH
SN7L
OL9W
F8KID
OE1W
OM8A
TM0W
S59DEM
IK2CFR
IK5ZWU/6
Legend
QRB<=1100
POINTS
100K
1M
1.5M
2M
2.5M
2.6M
2.7M
2.8M
2.9M
3M
3.1M
Call Density
per 0.3 deg
3 - 10
11 - 25
25 - 44
45 - 65
66 - 87
88 - 106
107 - 128
129 - 154
155 - 187
188 - 221
222 - 246
247 - 279
1.000
Kilometers

10. How to better estimate what could be the achieved

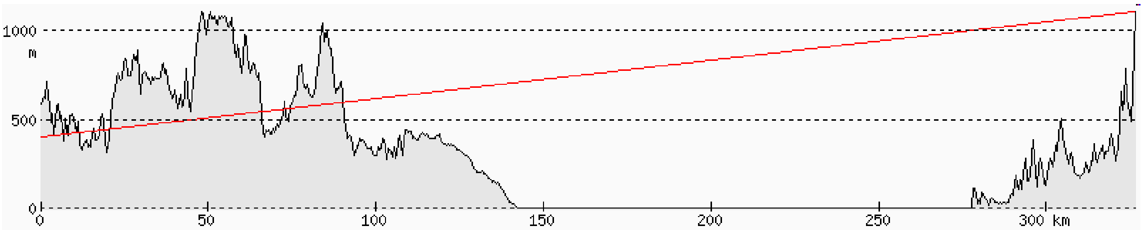
After creating those fine maps we questioned ourselves how to better evaluate the **potential of a particular contest location**. So Peter/s52aa came out with an idea to use ODX QRB as a representation of the **geographical and technical capabilities** of each participating station. Each station would be able to work all other stations that are within its ODX QRB circle and within the other station ODX QRB circle. The sketch below graphically represents the idea.

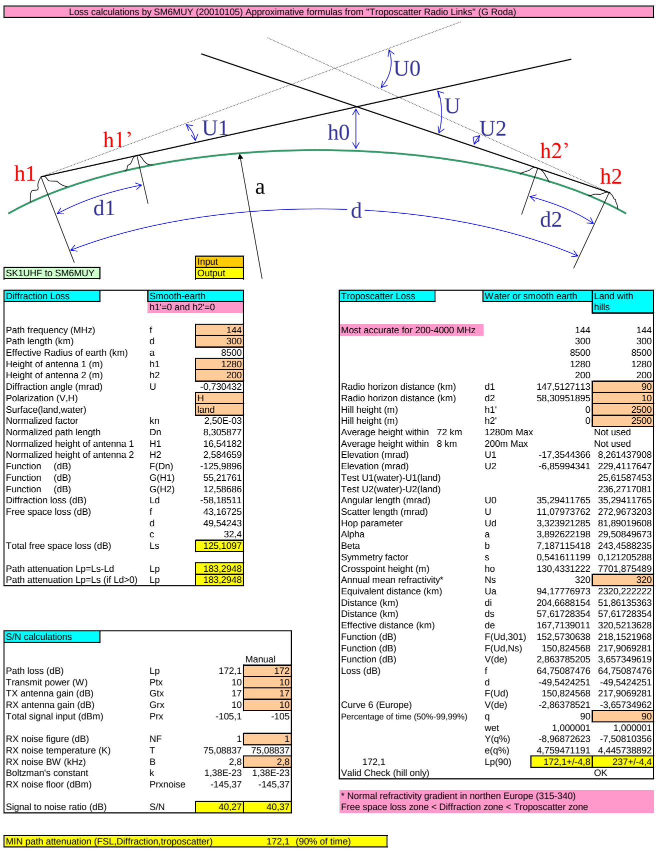


The EU map with locations that comply to the constraint that the QSO is workable if QRB < min(ODX QRB1, ODX QRB2) and limiting ODX QRB to 800 km (to exclude MS and ducting QSOs, i.e. to better represent the normal troposcatter ODX QRB) is shown below. **We can see that best locations are limited to around 700k points**. Please note that if some excellent location was not operated in this contest then it is not shown on this map (only locations of participating stations can be presented by this method).



Getting to the score that is realistically achievable should be relatively straightforward with today tools. It would be relatively easy to plot QSO path profile and then calculate troposcatter path loss (using ITU-R P.2001-1empirical formulas, for example; XLS calculator from SM6MUY is shown below).





The main obstacle is knowledge of the exact LONG/LAT coordinates. UL is way too coarse; for example, missing the location of S59DEM by 100m is kicking us 700m deep into the valley. The next challenge would be getting the equipment details (antenna gain, antenna height and TX power) for the stations that did not send the log.

With the tools available today at least troposcatter calculation could be done fairly simply and user friendly (using google maps as underlay, for example). It should also be possible to create troposcatter coverage maps for selected location and assuming some average state of equipment on the other side (i.e. 50W and 11 dBi), but it would require quite some processing time.

So how can we predict what would be maximum obtainable score for a particular station without entering tedious calculations? **One way is to use historical/statistical data**. We took the logs of top stations from last 8 years. Unfortunately not all stations were QRV every year, so we limited the analysis to the stations that were QRV 5 times or more. Then we created a database of different call signs worked during those years for each station. For example, S59DEM worked 2075 different call signs in last 8 years. As a last step we took the intersection of the history database and the database of all active calls in the 2014 contest (4437). For S59DEM the joint number of calls was 939 (we only made 742 of those☹). The table below shows what could be scored in 2014 VHF contest by some of the top stations (the contest evaluation was done by VHFMANAGER robot designed and maintained by S52AA and with the logs we had in hand and it does not represent official standings!). **The "% worked PTS" number indicates how far from the limit is each station**. For example, SN7L is close to the limit of their location for the equipment they use today, while OL9W has still a lot of margin. Of course, this analysis assumes that all the stations (including their correspondents) were using more or less the same equipment during those 8 years.

				Worked		8 years history			
Place	PCALL	PWWLO	ODX QRB	QSOs	PTS	QSOs	PTS	% worked PTS	Years
1	DL0GTH	JO50JP	1038	1119	435336	1479	573283	132%	8
4	SN7L	JO70SS	1463	866	351186	1029	415488	118%	5
9	OL9W	JN99CL	1262	799	320001	1349	547648	171%	6
13	DR2X	JO40QL	1275	856	303800	1216	438656	144%	8
14	S59DEM	JN75DS	1037	742	300234	939	390427	130%	7
15	DK0BN	JN39VV	946	775	283686	1044	388156	137%	5
16	OM8A	JN87WV	1040	693	267102	832	323934	121%	5
18	OL4A	JO60RN	929	719	260116	1066	395535	152%	6
19	OK1KCR	JN79VS	934	720	258879	989	375080	145%	7
20	OL3Z	JN79FX	932	736	252737	966	338140	134%	7

11. Conclusion

In this article we tried to give some insight into the guts of the IARU R1 VHF contest – the largest 2m contest in the world. While activity trend is going down the winner's results are more or less constant. We tried to present and describe some physical limitations to get to higher number of points, like maximum number of QSOs, and still it is hard to clearly show why the result in average stays flat. If a large enough collection of logs would be available for many more years back, very interesting analysis could be done. Unfortunately all that data is lost forever so we can only speculate. So let me speculate:

- activity is going down drastically, at least from 2006 on, but technical capabilities of participating stations are going up (in particular TX power)
  - so more distant stations can be worked (remember 8 dB/100 km troposcatter loss)

- not only winning stations are nowadays equipped with multiple antenna systems (remember that even in the 90's every winning station had multiple antenna systems with good power)
  - so more stations can be worked (note that the best technical setup to win a contest is still the one that would allow to TX into all directions all the time and also listen to all directions all the time; as we are working in half- duplex mode, only less than half of all the time is available for TX or RX)

- with more stations being equipped with high power and many antenna systems, more interference is in the air
  - so less distant (low signal) stations can be worked

At the moment it looks like the better technical equipment compensates well for the lack of stations while still not creating too heavy interference environment to the top locations/stations. I speculate then, that at some point in the future, the average best score will start to decrease and I really hope that it will never end at the value of the year 1956☺!

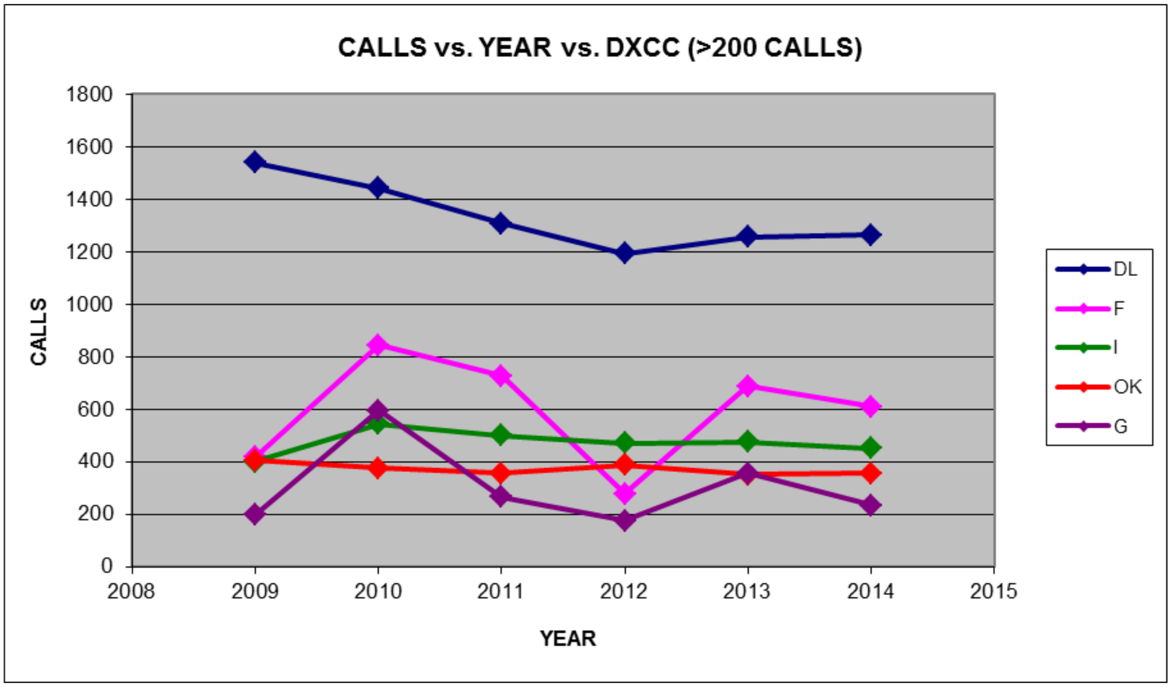
Although the title of this article (Where are the limits?) imposes that the addressed public is only topline pretenders, I believe it contains valuable information also for "small pistols", VHF managers, maintainers of contest robots and "stop-by" contesters.

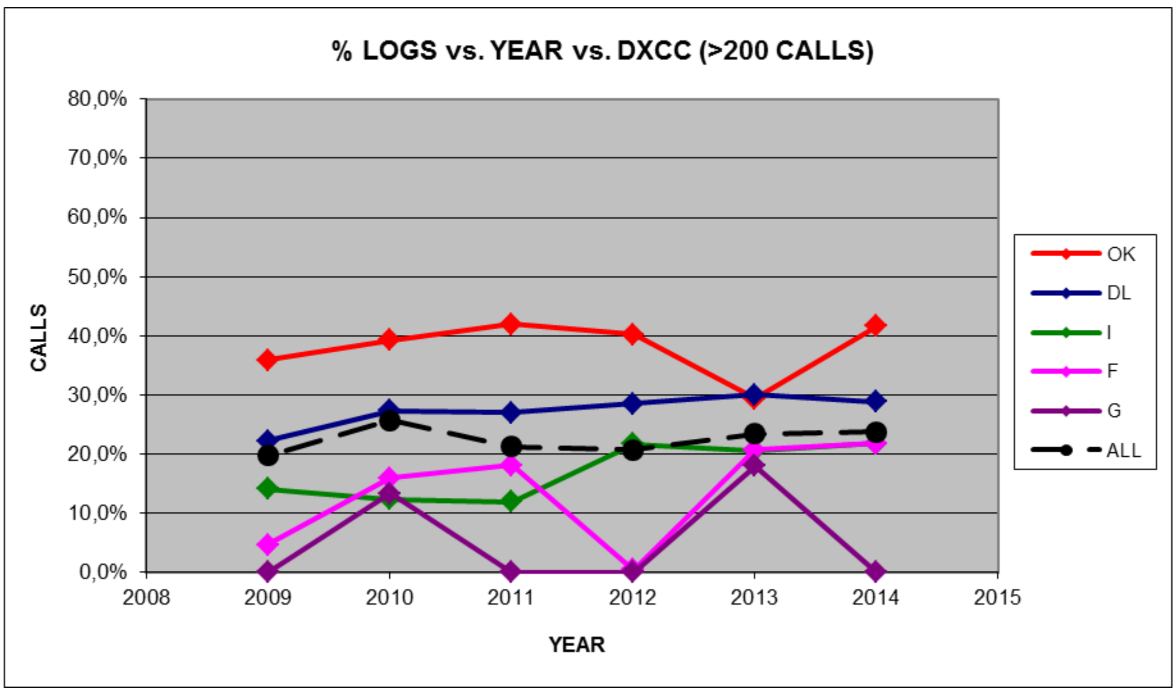
Ljubljana, August 2015 **73 de Robi/s53ww**

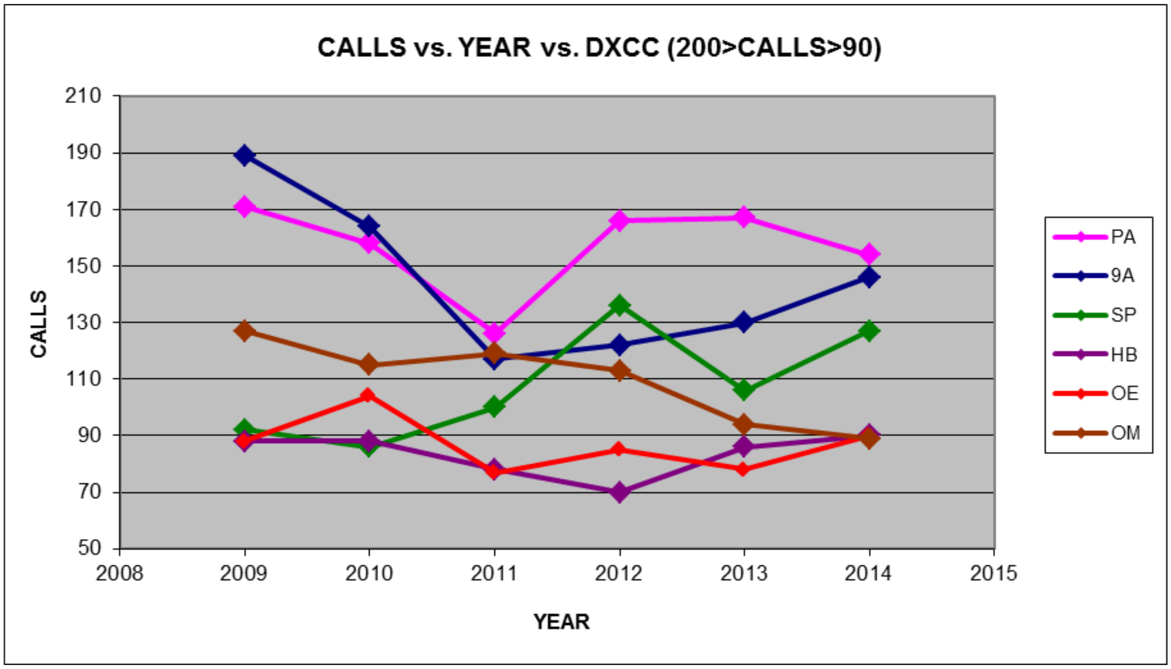
12. Appendix

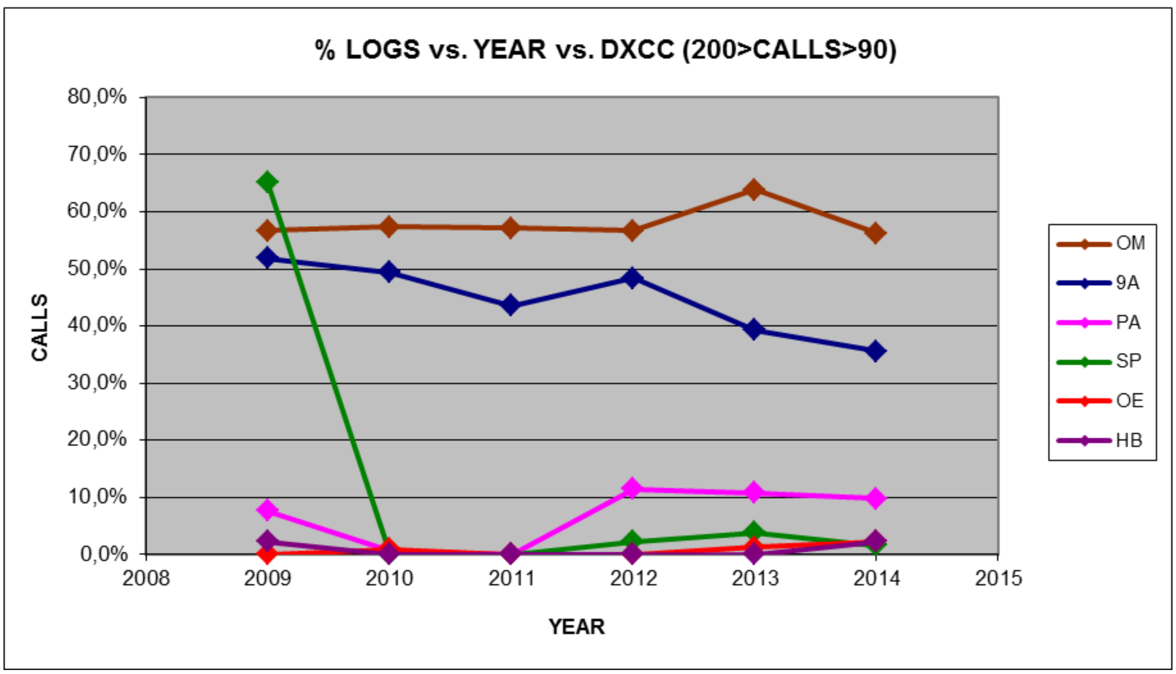
	2014				2013				2012				2011			
DXCC	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**
4O	1		0,0%		1		0,0%		1		0,0%		1		0,0%	
7X	1	1	100,0%				0,0%				0,0%				0,0%	
9A	146	52	35,6%	12	130	51	39,2%	12	122	59	48,4%	14	117	51	43,6%	4
9H	1		0,0%				0,0%				0,0%				0,0%	
CT			0,0%				0,0%				0,0%				0,0%	
DL	1262	363	28,8%	216	1256	377	30,0%	200	1193	340	28,5%	194	1306	352	27,0%	198
E7	52	20	38,5%	6	46	12	26,1%	2	62	1	1,6%	9	44	1	2,3%	3
EA	42		0,0%	5	39	1	2,6%	2	5		0,0%		31		0,0%	4
EI	3		0,0%		1		0,0%		1		0,0%		1		0,0%	
ER	4		0,0%		4		0,0%	1	5		0,0%	2	2		0,0%	
ES	2		0,0%		7		0,0%	2			0,0%				0,0%	
EU	10		0,0%		7		0,0%		10		0,0%		13		0,0%	
F	610	133	21,8%	125	685	141	20,6%	169	274	1	0,4%	9	720	129	17,9%	158
G	213		0,0%	14	305	51	16,7%	73	157		0,0%	4	237		0,0%	24
GD	3		0,0%	1	1		0,0%		1		0,0%		1		0,0%	
GI	2		0,0%		3		0,0%		1		0,0%		2		0,0%	
GJ			0,0%		3	1	33,3%	1			0,0%				0,0%	
GM	5		0,0%		24	7	29,2%	8	5		0,0%		5		0,0%	
GU	1		0,0%		1		0,0%		2		0,0%		1		0,0%	
GW	10		0,0%	1	19	5	26,3%	1	8		0,0%	1	20		0,0%	1
HA	61	6	9,8%	1	62	8	12,9%	4	59	16	27,1%	2	78	18	23,1%	5
HB	90	2	2,2%	8	86		0,0%	12	70		0,0%	8	78		0,0%	8
I	451	98	21,7%	73	475	97	20,4%	82	471	102	21,7%	99	498	59	11,8%	106
LA	2		0,0%	1	2	1	50,0%		1		0,0%		2		0,0%	
LX	2		0,0%		6	1	16,7%		4	1	25,0%		5	1	20,0%	
LY	16	12	75,0%	1	6		0,0%		6		0,0%	1	23	14	60,9%	4
LZ	27	5	18,5%		34		0,0%		31	1	3,2%	3	39	25	64,1%	2
OE	90	2	2,2%	9	78	1	1,3%	8	85		0,0%	7	77		0,0%	3
OH	4		0,0%	2	4		0,0%				0,0%				0,0%	
OK	356	147	41,3%	27	351	103	29,3%	32	388	156	40,2%	31	355	149	42,0%	23
OM	89	50	56,2%	2	94	60	63,8%	4	113	64	56,6%	8	119	68	57,1%	5
ON	80	5	6,3%	25	83	8	9,6%	18	58		0,0%	5	75	6	8,0%	7
OZ	36	1	2,8%	8	24	1	4,2%	13	23		0,0%	4	17		0,0%	4
PA	154	15	9,7%	26	167	18	10,8%	31	166	19	11,4%	33	126		0,0%	12
S5	85	41	48,2%	7	88	39	44,3%	4	98	32	32,7%	10	101	32	31,7%	9
SM	43	1	2,3%	6	58		0,0%	14	13	1	7,7%	2	9		0,0%	
SP	127	2	1,6%	6	106	4	3,8%	4	136	3	2,2%	5	100		0,0%	2
SV	50	2	4,0%	11	10		0,0%	1	22	1	4,5%	1	14	1	7,1%	3
SV9	1		0,0%				0,0%				0,0%				0,0%	
T7	3	2	66,7%	1			0,0%				0,0%		1		0,0%	
TA	1		0,0%				0,0%				0,0%				0,0%	
TA1	2		0,0%		1		0,0%		1		0,0%		1		0,0%	
TK			0,0%		3	1	33,3%	1	2		0,0%	1	5	2	40,0%	
UA	62		0,0%	1	66		0,0%		47		0,0%	3	2		0,0%	
UA2	4		0,0%	1	4		0,0%		5		0,0%	1	2		0,0%	
UA9	9		0,0%		6		0,0%		1		0,0%				0,0%	
UK			0,0%				0,0%				0,0%				0,0%	
UN			0,0%				0,0%				0,0%				0,0%	
UR	78	45	57,7%	5	96	52	54,2%	4	99	2	2,0%	4	30		0,0%	1
YL	1		0,0%		7		0,0%	2			0,0%		6		0,0%	
YO	47	14	29,8%	4	53	5	9,4%	2	42	2	4,8%	1	76		0,0%	4
YU	80	29	36,3%	15	106	34	32,1%	27	91	2	2,2%	6	105	37	35,2%	12
Z3	3		0,0%				0,0%				0,0%		3		0,0%	
ZA	1	1	100,0%		1	1	100,0%				0,0%				0,0%	
	4423	**1049**	**23,7%**	**620**	**4609**	**1080**	**23,4%**	**734**	**3879**	**803**	**20,7%**	**468**	**4448**	**945**	**21,2%**	**602**

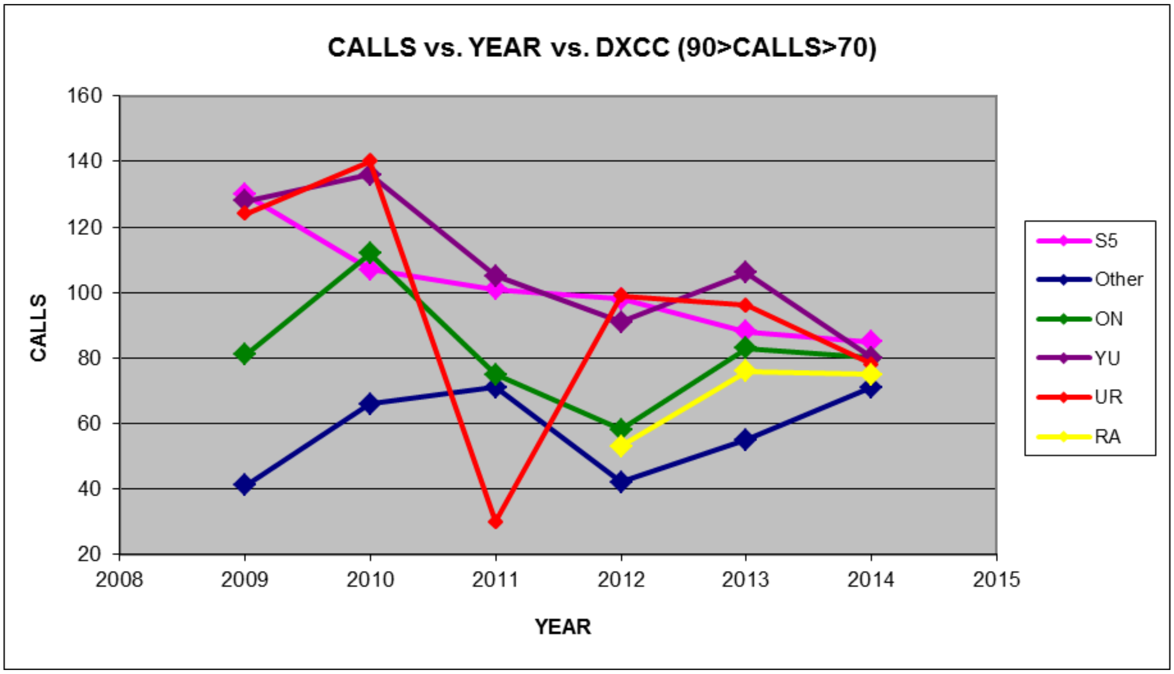
	2010				2009				2008				2007			
DXCC	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**	**Calls**	**Logs**	**% logs**	**Uniq w/ nr 1**
4O	2	1	50,0%				0,0%		1		0,0%		2		0,0%	
7X	1		0,0%				0,0%				0,0%				0,0%	
9A	164	81	49,4%	10	189	98	51,9%	6	207	82	39,6%	11	169	40	23,7%	18
9H			0,0%		1		0,0%		1		0,0%				0,0%	
CT	4		0,0%				0,0%				0,0%				0,0%	
DL	1442	393	27,3%	243	1538	342	22,2%	310	1826	401	22,0%	317	1786	403	22,6%	344
E7	58	26	44,8%	7	60	23	38,3%	6	85	9	10,6%	10			0,0%	
EA	83		0,0%	6	35		0,0%	1	157	64	40,8%	17	10		0,0%	
EI	4		0,0%		3		0,0%		3		0,0%				0,0%	
ER	2		0,0%		3		0,0%		1	1	100,0%		2		0,0%	1
ES	1		0,0%		2		0,0%				0,0%				0,0%	
EU	12		0,0%		5	1	20,0%		1	1	100,0%				0,0%	
F	838	163	19,5%	165	413	19	4,6%	32	724	123	17,0%	157	272		0,0%	8
G	490	65	13,3%	105	175		0,0%	7	371	29	7,8%	67	99		0,0%	5
GD	3	1	33,3%		1		0,0%		2		0,0%				0,0%	
GI	5		0,0%	2	1		0,0%		4		0,0%	1			0,0%	
GJ			0,0%				0,0%		1		0,0%				0,0%	
GM	69	5	7,2%	34	4		0,0%		60	4	6,7%	30	1		0,0%	
GU	3	1	33,3%		1		0,0%		4		0,0%		1		0,0%	
GW	25	7	28,0%	4	14		0,0%		22		0,0%	8	4		0,0%	
HA	78	18	23,1%	8	93	15	16,1%	8	98	17	17,3%	17	82	2	2,4%	3
HB	88		0,0%	13	88	2	2,3%	19	130	8	6,2%	18	88		0,0%	5
I	544	67	12,3%	103	398	56	14,1%	69	481	50	10,4%	113	279	3	1,1%	15
LA	2		0,0%		2		0,0%		5		0,0%	4			0,0%	
LX	4	1	25,0%		5	3	60,0%		12	2	16,7%	1	11		0,0%	
LY	11	7	63,6%	1	6		0,0%	1	10		0,0%		6		0,0%	
LZ	38	2	5,3%	3	17		0,0%	2	32	8	25,0%	3	17		0,0%	
OE	104	1	1,0%	8	88		0,0%	3	108	21	19,4%	21	86	5	5,8%	9
OH	1		0,0%				0,0%				0,0%				0,0%	
OK	375	147	39,2%	26	404	145	35,9%	61	408	138	33,8%	41	403	128	31,8%	58
OM	115	66	57,4%	5	127	72	56,7%	18	112	59	52,7%	9	138	64	46,4%	11
ON	112	7	6,3%	12	81	11	13,6%	6	111	11	9,9%	34	95	14	14,7%	9
OZ	15		0,0%	1	14		0,0%	2	29	1	3,4%	7	14		0,0%	
PA	158	1	0,6%	23	171	13	7,6%	39	198	13	6,6%	42	137		0,0%	8
S5	107	30	28,0%	8	130	30	23,1%	10	137	38	27,7%	18	112	33	29,5%	18
SM	22		0,0%	5	24		0,0%	4	58	1	1,7%	8	17		0,0%	
SP	86		0,0%	3	92	60	65,2%	6	87	53	60,9%	6	101	53	52,5%	9
SV	20		0,0%	3	25		0,0%	2	17		0,0%	2	6		0,0%	3
SV9			0,0%				0,0%		1		0,0%				0,0%	
T7			0,0%				0,0%		1		0,0%				0,0%	
TA	1		0,0%				0,0%		1		0,0%		5		0,0%	
TA1			0,0%		1		0,0%				0,0%		1		0,0%	
TK	5	1	20,0%		2		0,0%		2	1	50,0%				0,0%	
UA	208	157	75,5%	8	267	32	12,0%	14	202	22	10,9%	8	81		0,0%	1
UA2	4	3	75,0%		4	2	50,0%		2		0,0%		6	2	33,3%	2
UA9	116	95	81,9%	1	123	7	5,7%	11	57	5	8,8%	6			0,0%	
UK	1		0,0%				0,0%				0,0%				0,0%	
UN	2		0,0%		1		0,0%				0,0%				0,0%	
UR	140	101	72,1%	6	124	14	11,3%	9	121	59	48,8%	13	73	44	60,3%	4
YL	8		0,0%		6	1	16,7%		5		0,0%		2		0,0%	1
YO	77	26	33,8%	12	73		0,0%	5	94	48	51,1%	9	47	1	2,1%	3
YU	136	43	31,6%	9	128	30	23,4%	14	138	40	29,0%	19	106	26	24,5%	13
Z3			0,0%		1		0,0%		4	1	25,0%	1	1	1	100,0%	
ZA			0,0%				0,0%				0,0%				0,0%	
	5784	**1516**	**26,2%**	**834**	**4940**	**976**	**19,8%**	**665**	**6131**	**1310**	**21,4%**	**1018**	**4260**	**819**	**19,2%**	**548**

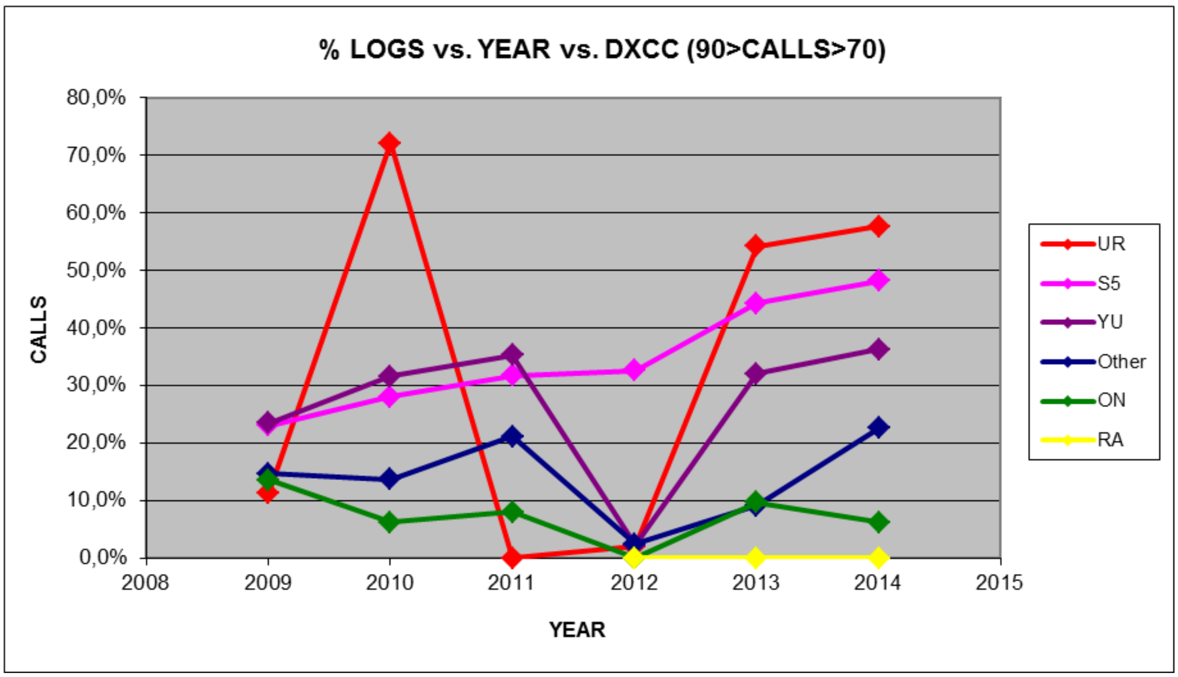

CALLS vs. YEAR vs. DXCC (>200 CALLS)
CALLS
YEAR
1800
1600
1400
1200
1000
800
600
400
200
0
2008
2009
2010
2011
2012
2013
2014
2015
DL
F
I
OK
G

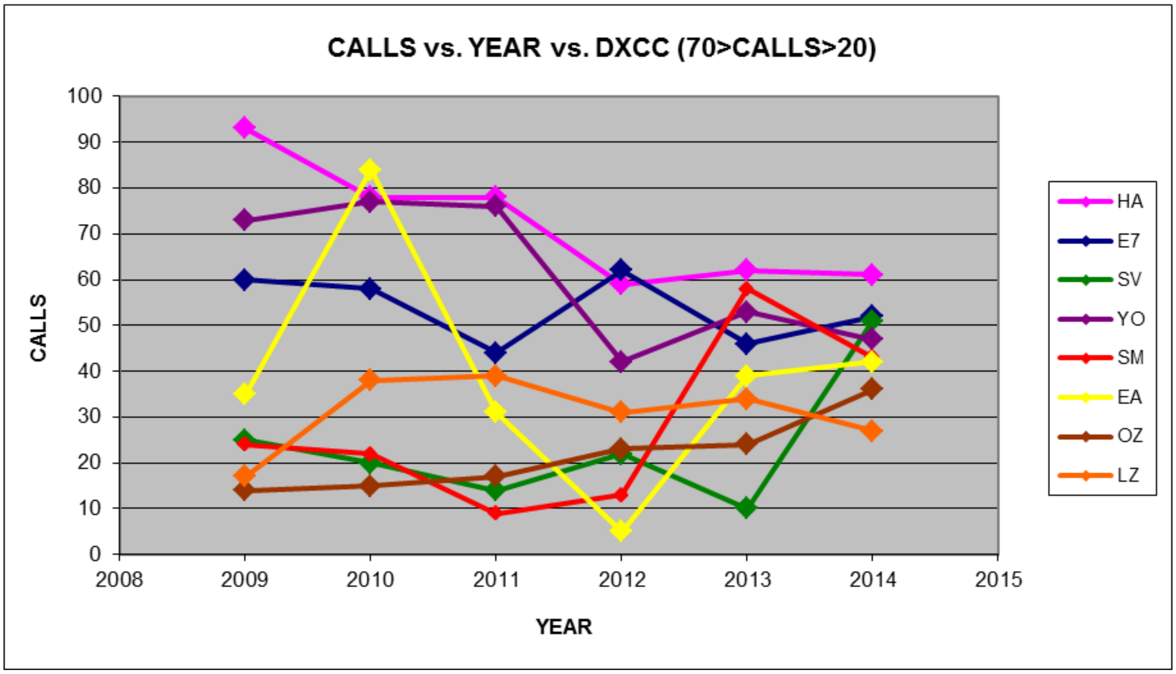

% LOGS vs. YEAR vs. DXCC (>200 CALLS)
CALLS
YEAR
80,0%
70,0%
60,0%
50,0%
40,0%
30,0%
20,0%
10,0%
0,0%
2008
2009
2010
2011
2012
2013
2014
2015
OK
DL
I
F
G
ALL

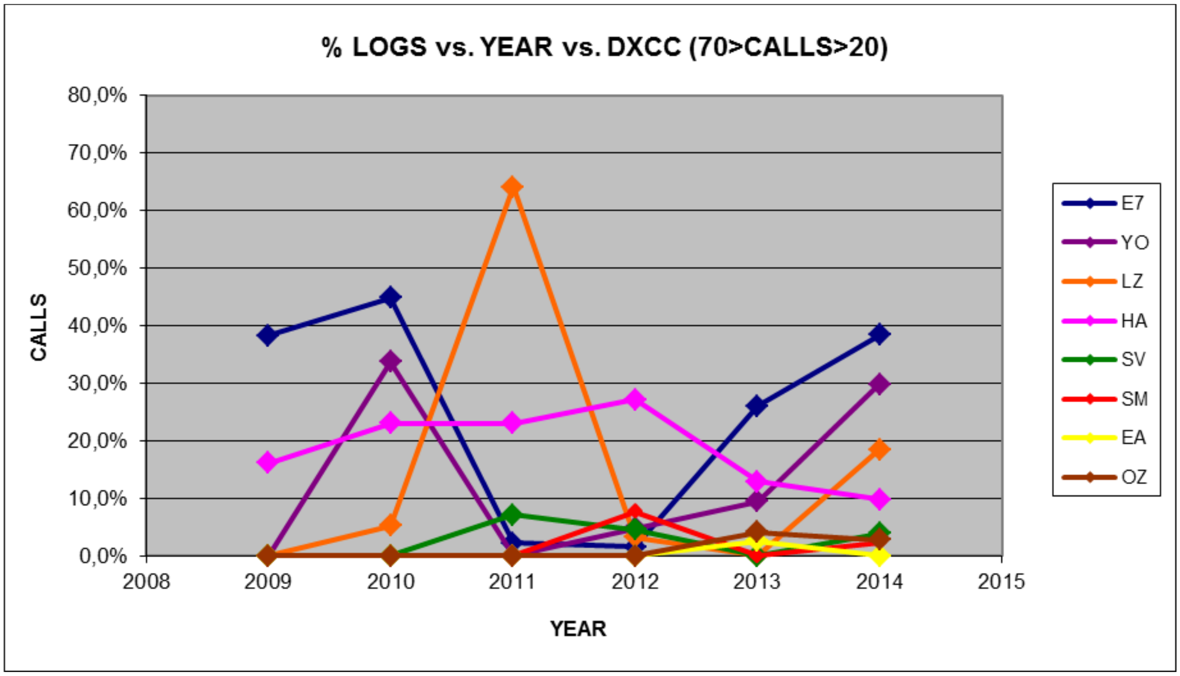

CALLS vs. YEAR vs. DXCC (200>CALLS>90)
CALLS
YEAR
210
190
170
150
130
110
90
70
50
2008
2009
2010
2011
2012
2013
2014
2015
PA
9A
SP
HB
OE
OM


% LOGS vs. YEAR vs. DXCC (200>CALLS>90)
CALLS
YEAR
80,0%
70,0%
60,0%
50,0%
40,0%
30,0%
20,0%
10,0%
0,0%
2008
2009
2010
2011
2012
2013
2014
2015
OM
9A
PA
SP
OE
HB


CALLS vs. YEAR vs. DXCC (90>CALLS>70)
CALLS
YEAR
160
140
120
100
80
60
40
20
2008
2009
2010
2011
2012
2013
2014
2015
S5
Other
ON
YU
UR
RA


% LOGS vs. YEAR vs. DXCC (90>CALLS>70)
CALLS
YEAR
80,0%
70,0%
60,0%
50,0%
40,0%
30,0%
20,0%
10,0%
0,0%
2008
2009
2010
2011
2012
2013
2014
2015
UR
S5
YU
Other
ON
RA


CALLS vs. YEAR vs. DXCC (70>CALLS>20)
CALLS
YEAR
HA
E7
SV
YO
SM
EA
OZ
LZ


% LOGS vs. YEAR vs. DXCC (70>CALLS>20)
CALLS
YEAR
E7
YO
LZ
HA
SV
SM
EA
OZ