

Regular 3000+Km Contacts on 144MHz by Meteor Scatter + Tropo

John Regnault G4SWX

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- Good Afternoon everybody and thank you for inviting me to speak at your conference.
- For those who have not heard me on the air I specialise in 144MHz DX and have done for over 40 years since I first got my first amateur licence.
- I only learnt Morse and took the 'A' licence test in 1982 in order to work moonbounce, EME.
- Although I have DXCC on 144MHz, terrestrial DX represents a special challenge.
- Today I am going to talk about regular, not quite every day, contacts on 144MHz over 3000Km by exploiting a combination of tropospheric ducting and meteor scatter propagation.

Regular 3000+Km 144MHz Contacts?

The American Radio Relay League, Inc. DX CENTURY CLUB

This Certifies that

John Regnault, G4SWX

Has this day submitted evidence to the American Radio Relay League showing two-way communication with other amateur stations in at least one hundred different countries. This certificate recognizes outstanding performance and attests to membership in the DX Century Club.

- Propagation by meteor scatter & tropospheric ducts
- A mechanism previously not deliberately exploited
- Evaluation of MS + Tropo paths
- Trans-Atlantic possibilities !

2 Meters

133

October 16, 2014

Kay Craigie

President, ARRL

N3KN

- Some of you may not have heard about the large numbers of recent long distance contacts made by combining tropospheric ducting and meteor scatter propagation.
- Some of you may even think that this is impossible.
- I will introduce you to some of the reasoning as to why myself and a number of Dutch amateurs thought it was possible.
- What then happened when EA8TJ tried FSK441 meteor scatter during the Perseides meteor shower in 2013 and how many further contacts have resulted, mostly with 'random' meteors.
- In the talk I will be covering how I think the propagation mechanisms couple, some results. A short burst of trans-Atlantic reception and then some guidance on how to exploit this mode.

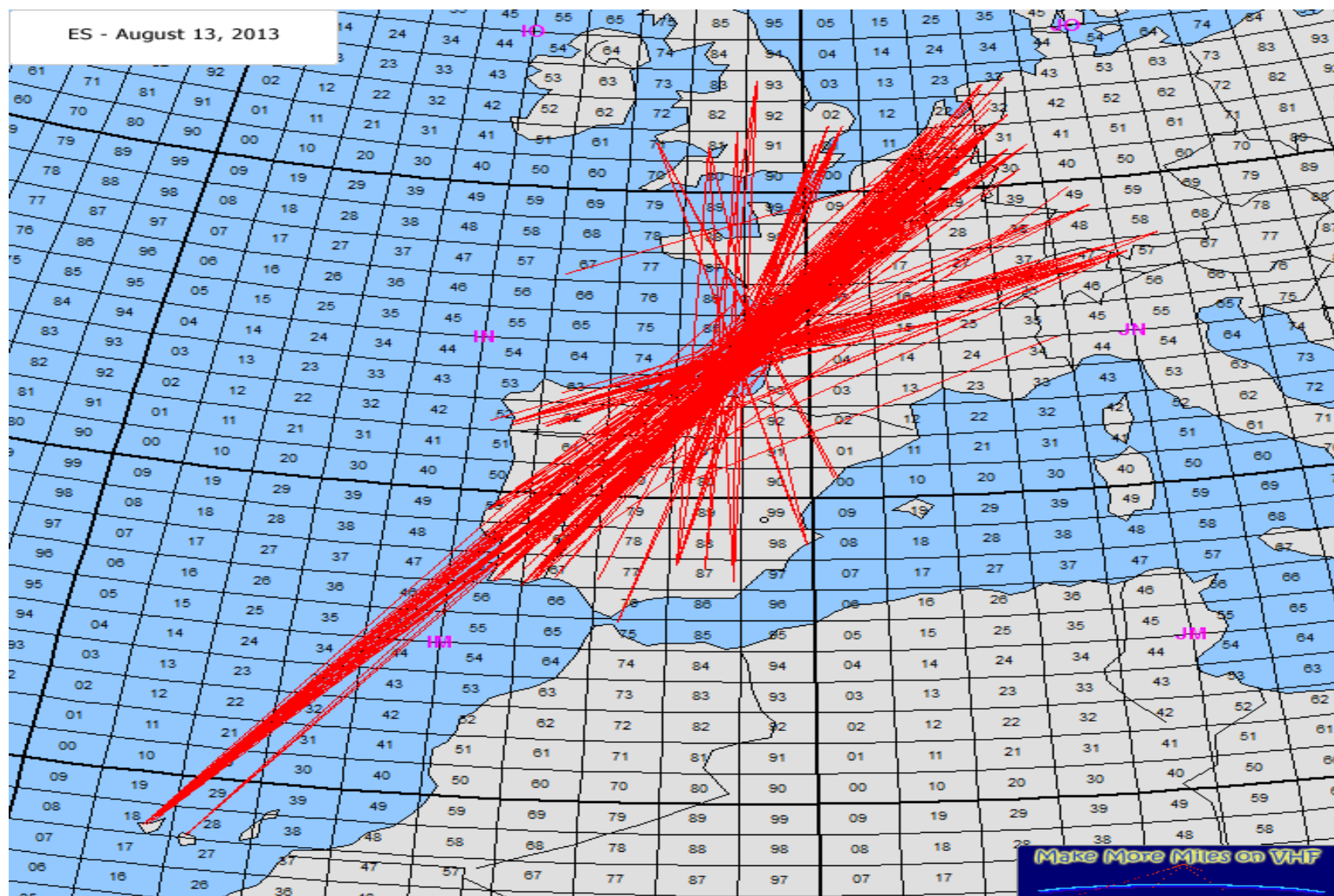
Before August 2013 >2500Km MS

Date	Call A	Loc A	CallB	Loc B	QRB Km
13-12-1985	K5UR	EM35wa	KP4EKG	FK68vg	3162
12-08-1977	GW4CQT	IO81lp	UW6MA	KN97ve	3101
09-08-2005	G4LOH	IO94ea	RW3PF	KO93cd	2605
08-08-2003	G4LOH	IO94ea	RU3ACE	KO95kg	2581
13-08-2009	N6RMJ	DM14cp	K2DRH	EN41vr	2528
19-11-2003	ES6RQ	KO28wa	EA3AXV	JN01tj	2518

- The above chart is a compilation of IARU Region 1 and ARRL records showing the longest meteor scatter contacts on record, before August 2013.
- What I will say at this stage is that I can easily explain the propagation mechanisms for four out of these six contacts!
- Reception of signals propagated by meteor scatter and tropo at up to 2900Km were first reported in Australia, VK in 2006. It was then reported in Dubus 4/2012 that New Zealand ZL and Australian VK amateurs had made contacts in the 2100-2350Km range.

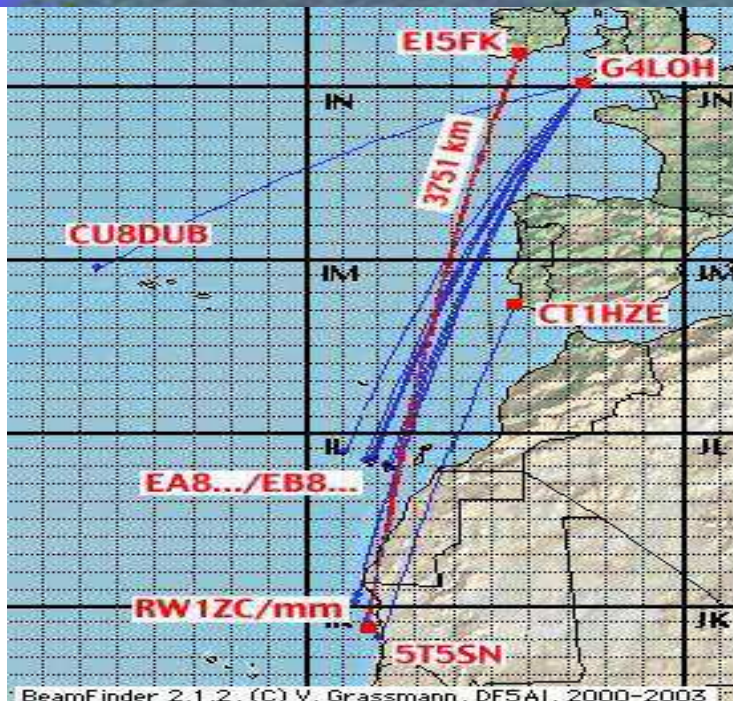
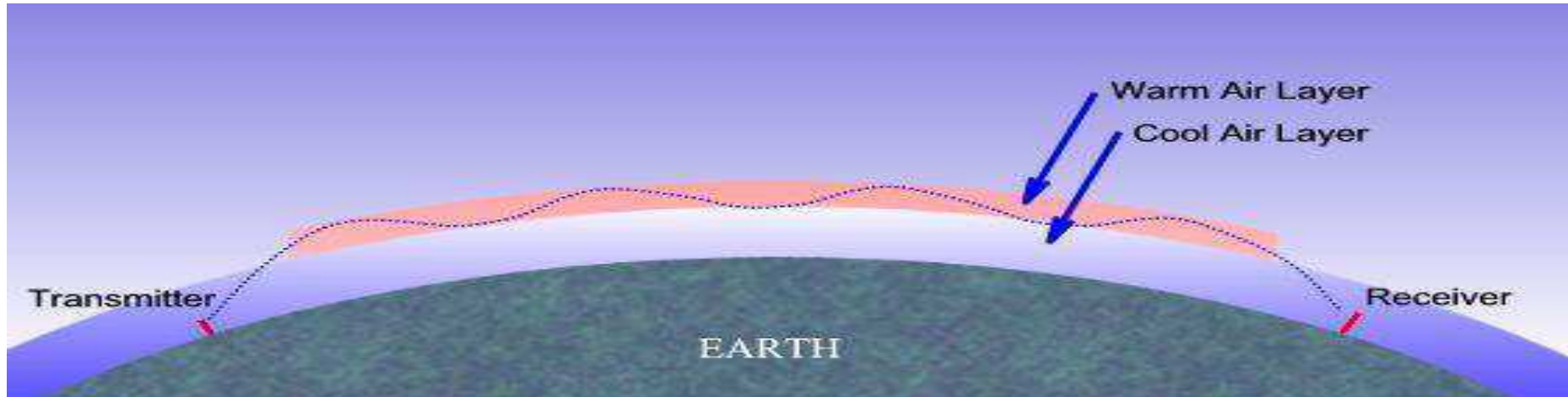
3000+Km Contacts via Sporadic E

August 13 2013



- This map, for the 13th August 2013 taken from the Make More Miles on VHF website is a good example why a number of stations have claimed sporadic E contacts >3000Km
- During this opening there were quite a number of contacts from the North of Germany to the Canary Islands EA8.
- During discussions with a number of my local Dutch Dxers and Joe Kraft CT1HZE we concluded that many contacts that had previously been classified as 'Sporadic-E Propagation' were in fact a combination of sporadic-E and tropospheric ducting.
- In this case sporadic-E propagation from Germany to the Portuguese coast and then a tropospheric duct across the nearby Atlantic Ocean to the Canary Islands EA8.

Atlantic Coast Tropo Ducting



Many QSO from CT, EA, F, G & EI to EA8 & D4

The new 432MHz Record:

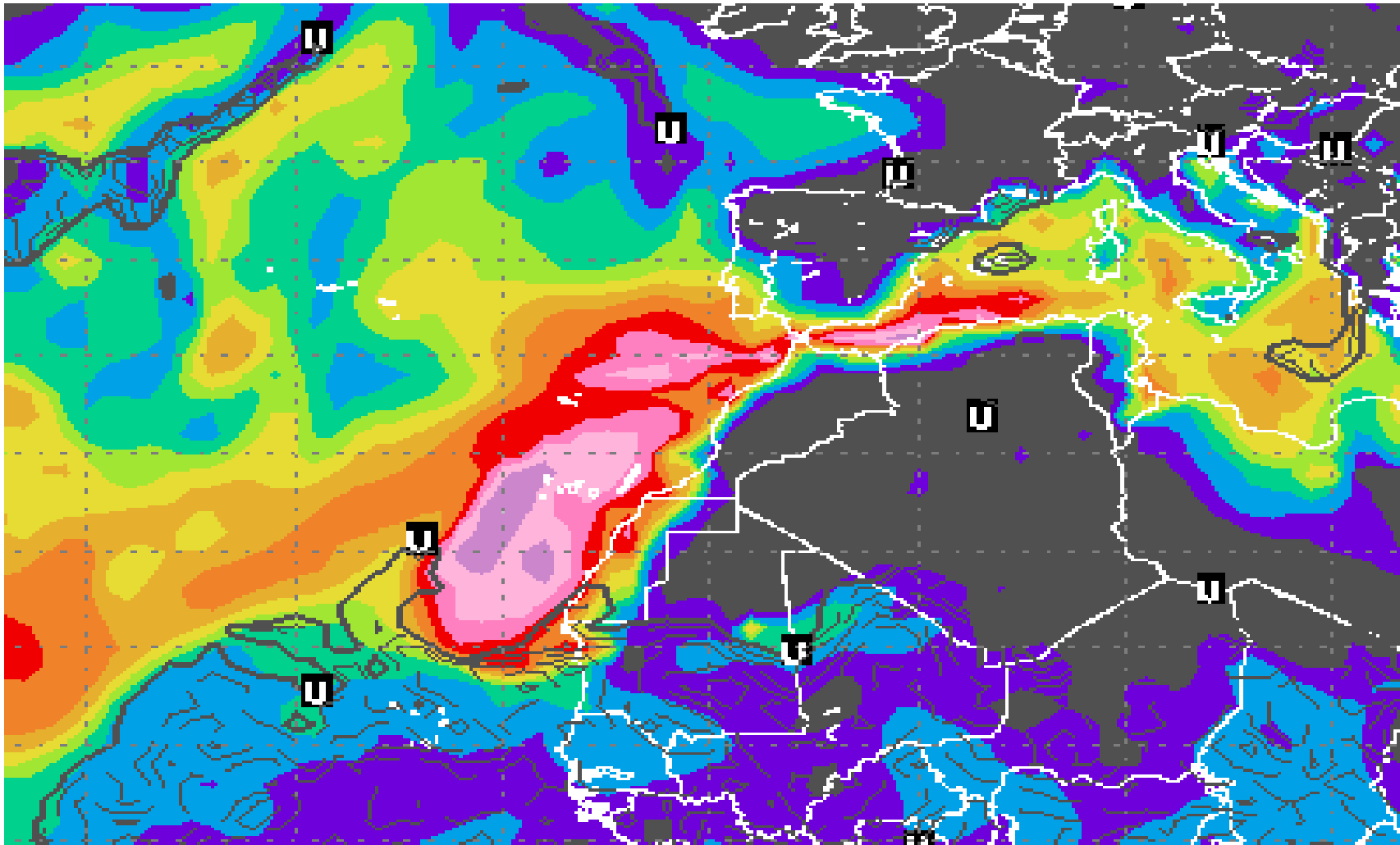
9th July 2015 at 19:16

G4LOH worked D44TS 432MHz CW
IO70jc to HK77ke 4070km

- Tropospheric ducting occurs when a layer of warm air becomes trapped between colder air. The refractive index difference provides a guide along which VHF and microwave signals can be propagated, often with very low loss.
- The coastline on the Eastern side of the Atlantic often supports tropospheric ducts for much of the summer months and has provided many record breaking paths from the Canary Islands EA8 and Cape Verde Islands D4 to Northern European stations close to the Atlantic coast.
- The latest record breaking contact was last month on 9th July 2015 when G4LOH worked D44TS on 432MHz CW. This was the only tenth ever 432MHz QSO for G4LOH!

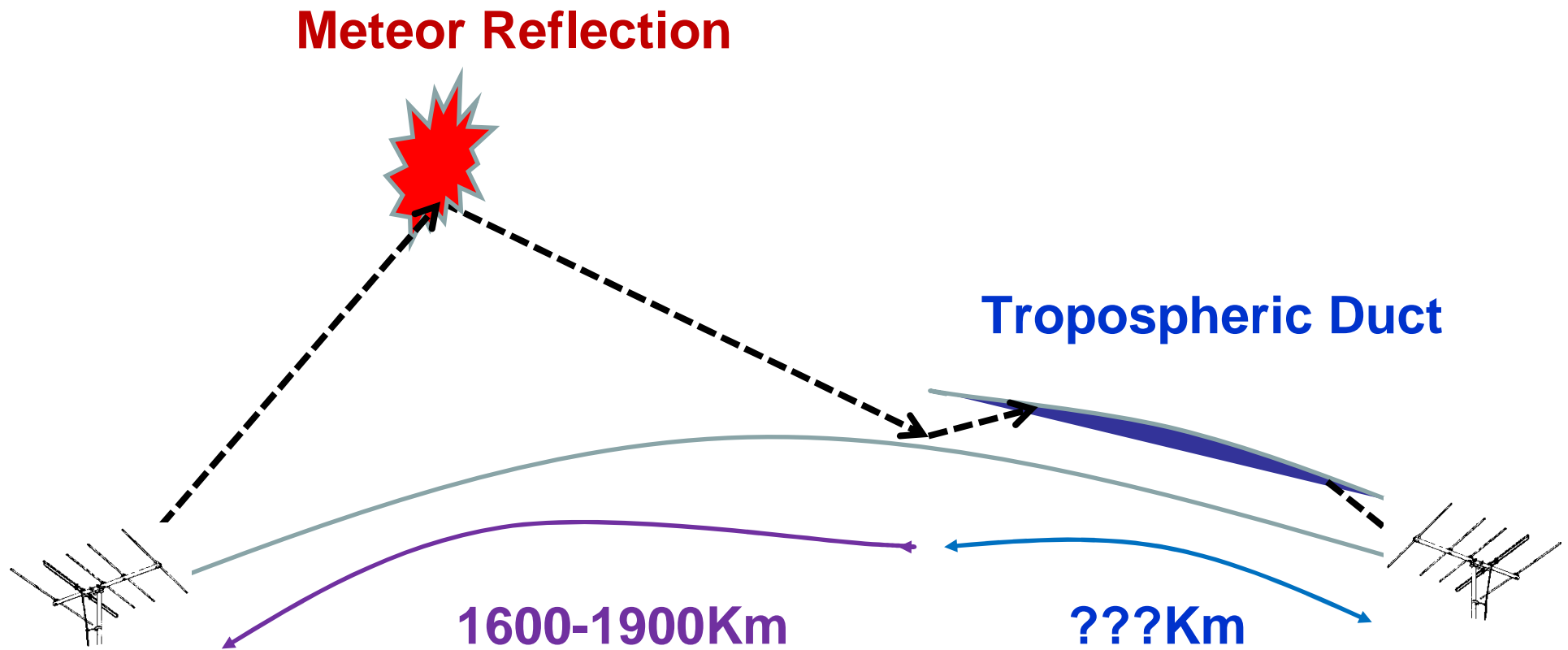
Hepburn Tropo Map

August 13 2013



- Returning to August 13th 2013 where I previously showed a maps with sporadic E contacts between Germany DL and the Canary Islands EA8 this is the Hepburn tropo prediction map for that afternoon. The brighter red areas along the Atlantic coastline represent the strongest ducting. Indeed stations in the Canary Islands EA8 were reporting very strong tropo signals from Portugal CT all day.
- The simplest explanation of the 3000+Km contacts from the Canary Islands EA8 into Germany DL is that signals propagated by sporadic E were reflected off the sea near Portugal and were carried to EA8 in a tropospheric duct.

Coupling meteor reflections into a tropospheric duct



- The principal of coupling two VHF propagation mechanisms together is relatively simple, I have just shown how many contacts have been made which combine sporadic E and tropo.
- So it should be possible that signals propagated by meteor scatter should propagate onwards in a tropospheric duct in the same way as those propagated by sporadic E.
- This is how I think the coupling mechanism works. The diagram is not to scale, as the meteor reflection will be around 90Km above the earth whilst the tropospheric duct is only a few hundred metres above the ground.
- The most important aspect is the angle of entry into the tropospheric duct.
- If this is too large then signals will not be effectively coupled into the duct.
- Between one and three degrees seems to be optimum at 144MHz to couple into the ducts over the coastal regions of the Atlantic Ocean.
- “ Normal” good tropo will not reflect signals with an angle of more than a fraction of a degree, hence tropo ducts are essential. These sub tropical ducts however are often extremely strong and reflect signals at angles as much as 1...3 degrees (which is extreme!)
- 1600Km range represents about 3 degrees elevation, 1900Km range is just over 1 degree and random meteors producing reflections over 1900Km are rare.

Dedicated MS + Tropo Tests

Date	Time	Call	Wkd	Comments
12 August 2013	11:49:21	HB9EFK	EA8TJ	jn46je<MS>il18rj 2967km !!!
12 August 2013	12:35:41	ON4AOI	EA8TJ	IL18RJ<>JO21BA FB MS 3052KM
12 August 2013	14:07:30	PA3BIY	EA8TJ	CR MS!!! Wkd at 13:50 3160km!
12 August 2013	15:21:19	PA4EME	EA8TJ	JO20WX<MS>IL18RJ 3133km !!
12 August 2013	20:36:12	S50C	EA8TJ	Domingo mny tn timer for QSO 3375 k
13 August 2013	08:15:41	PA5KM	EA8TJ	IL18<MS>JO11 MS+tropo FB !!
13 August 2013	16:34:46	HB9FAP	EA8TJ	JN47PH<MS>IL18RJ 3067km
13 August 2013	17:34:16	I2FAK	EA8TJ	JN45OB<MS>IL18RJ 2929 KM
14 August 2013	10:40:56	DF2ZC	EA8TJ	IL18RJ<MS>JO30RN 3186 km
14 August 2013	21:31:40	G4SWX	EA8TJ	IL18<MS>JO02 3040Km best 300/6

- During the Perseides meteor shower in 2013 Domingo EA8TJ who had recently become active on 144MHz JT65 EME tested FSK441 meteor scatter. Within 45 minutes of first calling CQ EA8TJ had completed his first QSO with HB9EFK at a distance of almost 3000Km. In two more days he completed 10 QSOs and was heard by scores of other stations. This is a clip of the DX cluster spots.
- I was very lucky to get a second chance after EA8TJ abandoned our first QSO attempt on 13th whilst sending 'RRR' as a sporadic E event had just started.

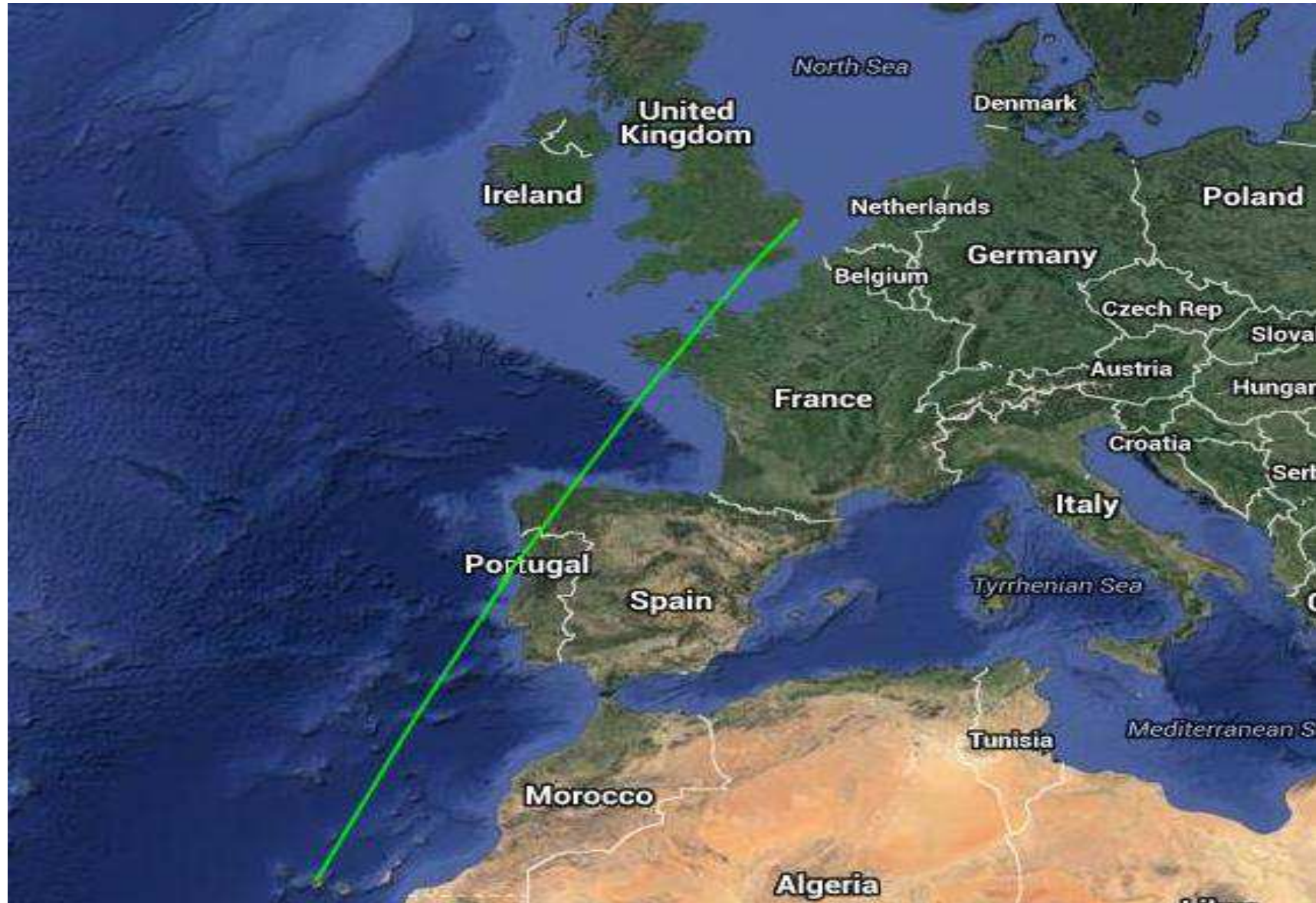
1600-1900Km from G4SWX JO02rf



- If we now look at the range of low angle meteor reflections from my location in Eastern England you can see that in the range of 1600-1900Km in the direction of the Canary Islands, EA8 these reflections will hit the Atlantic Ocean just off the coast of Portugal.

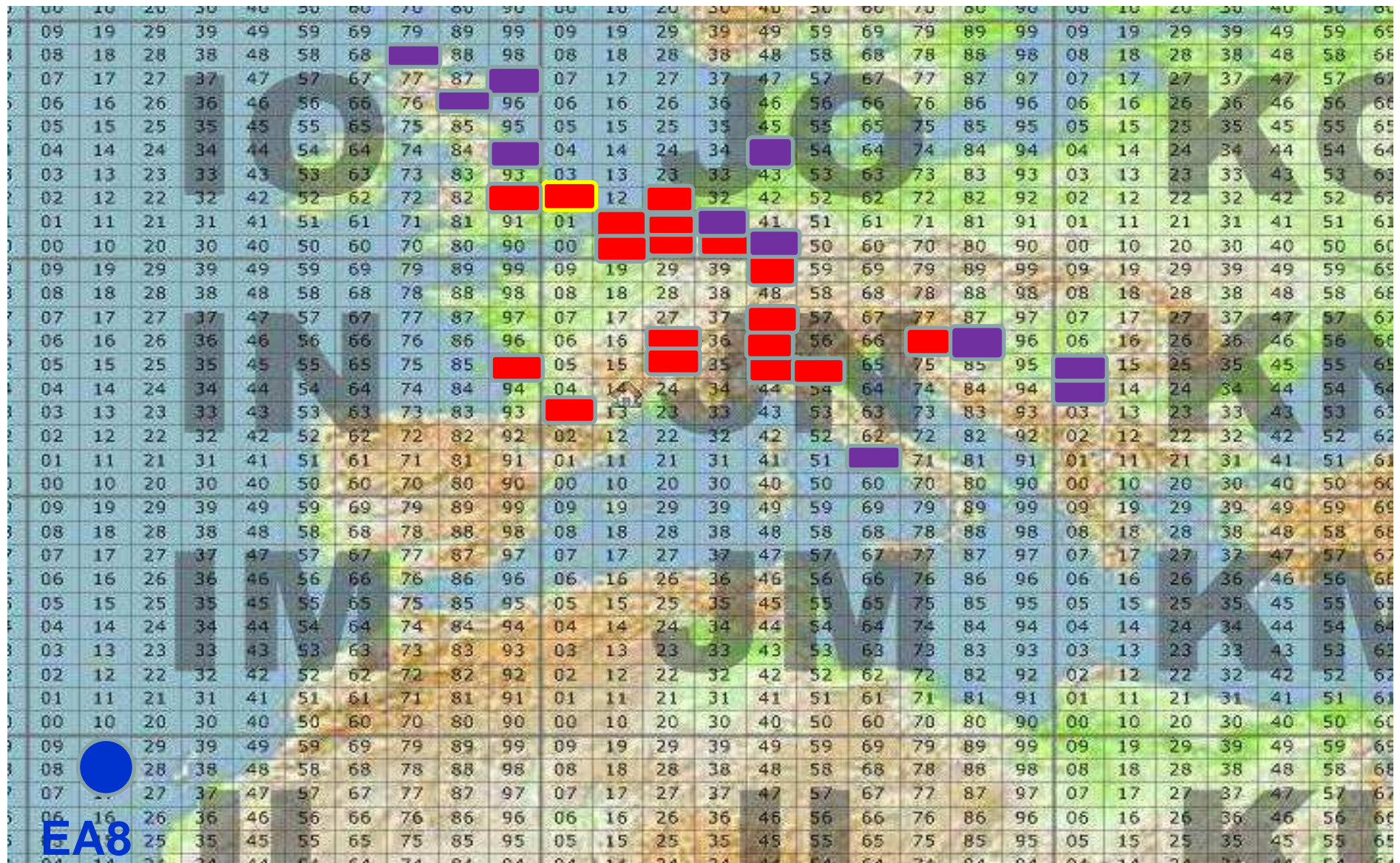
- Some people have suggested that the refractive index change at the coast is responsible for the coupling into the tropospheric duct. However, there have been reception reports where the reflection point is a long way out at sea. In my opinion the sea reflection is an important feature to ensure that the two propagation mechanisms couple together.

G4SWX – EA8TX 3050Km



- The path from EA8TX to my station in Eastern England is 3050Km.
- Unfortunately unlike many other UK stations those in the South Eastern part are not able to work the Canary islands EA8 by tropo. The path includes 150Km of land in the UK, 150Km in France and 100Km of mountains in Northern Spain.
- However as you have seen from the previous slide signals propagated by meteor reflections hit the sea just to the West of Portugal. It is these low angle, between 1 and 3 degrees incidence with the sea, that are then captured by the tropospheric ducts that regularly exist along that coast.
- This year during many FSK441 tests with EA8TX, signals were received on most days when the tropospheric conditions looked suitable, over this 3050Km path. About one in three tests resulted in a two way QSO which often took up to 1 hour.

Worked & Heard EA8TJ/EA8TX



- Since the start of the meteor scatter + tropospheric propagation tests in August 2013 the distance record for meteor scatter has been broken many times.
- There have now been about 50 such contacts made by EA8TJ and EA8TX shown as red coloured locator squares. Many of these QSOs are over 3000Km. I have been lucky to have made 10 such QSOs
- Even more interesting are the reception reports shown as purple coloured locator squares
- The current record of EA8TJ to S50C, JN76 of 3377Km is clearly one that can now be broken by stations who understand when this propagation mechanism is possible and have the station capability and the time to test.
- The furthest reception reports that I am aware of are OZ1LPR JO44, 3629Km, YU1EV KN04 3714Km and YU7TT 3775Km.
- The reports from Serbia are interesting as it looks as though the ducts run from the Canary Islands EA8 up into the Mediterranean Sea.

OK2KKW note: as well as OK stations have QSOs on 144MHz with EA8, for example OK1TEH with EA8BTV (later EA8TX), on 20.5.2003, QRB 3567 km).

EA8TX Single Yagi on 144MHz



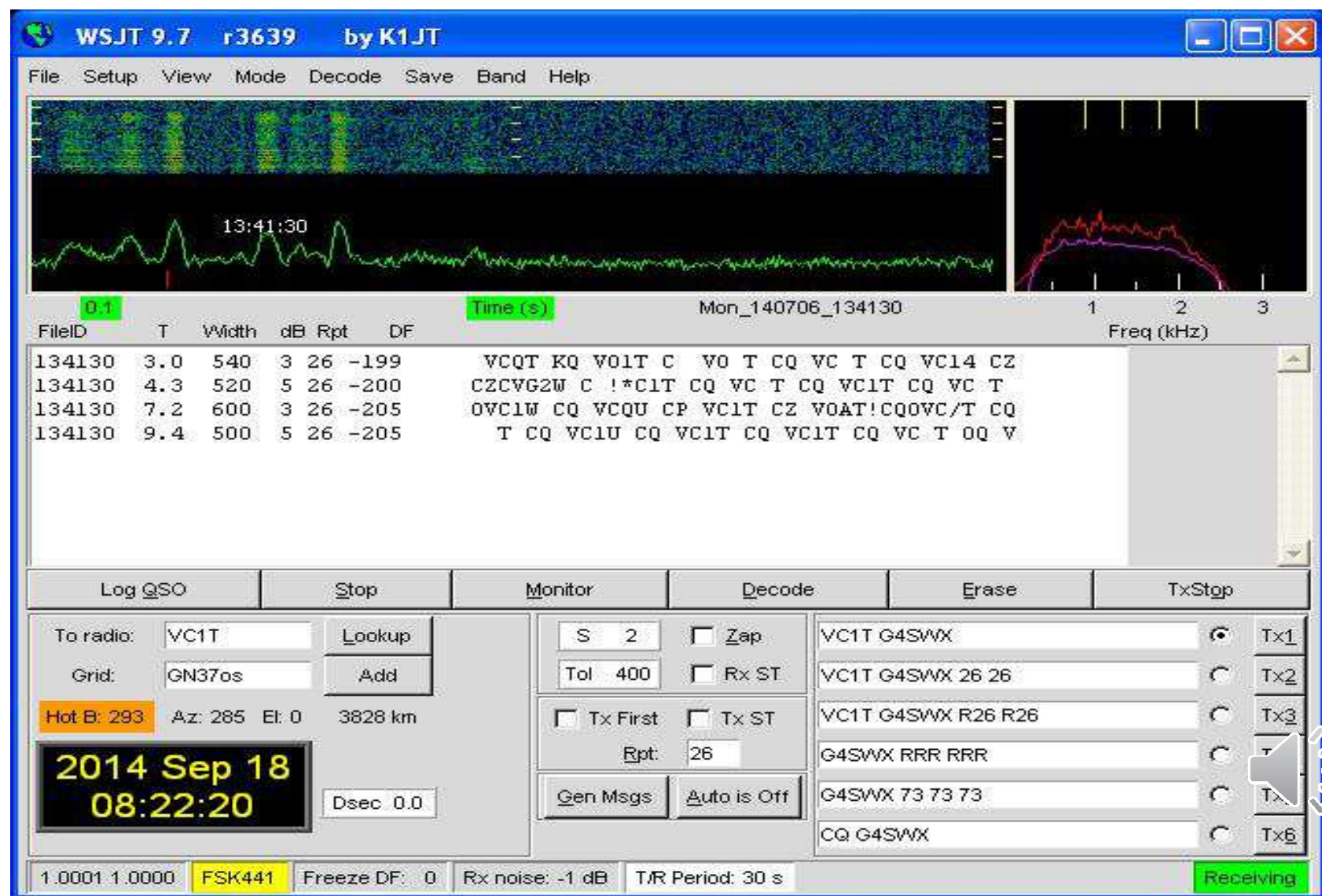
- Over the last six months I have carried out many tests with Fernando EA8TX
- *** Play audio of G4SWX received at EA8TX: G4SWX_150509_184830.WAV
- This is 4.5 seconds of RRRR received at 13dB over noise on 9th May 2015 during one of many tests



- This was recorded with what Fernando EA8TX calls his 'basic set-up': only IC706MKIIG + Mirage 100W + Vargarda 9EL2!

OK2KKW note: picture of EA8TX antennas has made by OK1TEH when he visited him on Tenerife island.

A 3730Km Reception Report – VC1T



- On 6th July 2014 I was monitoring the 144MHz frequency of the trans-Atlantic DXpedition VC1T.

- As I am located 500Km away from the Atlantic coast I did not expect to hear anything but was interested in monitoring backscatter from callers.

- Imagine my surprise when I heard:



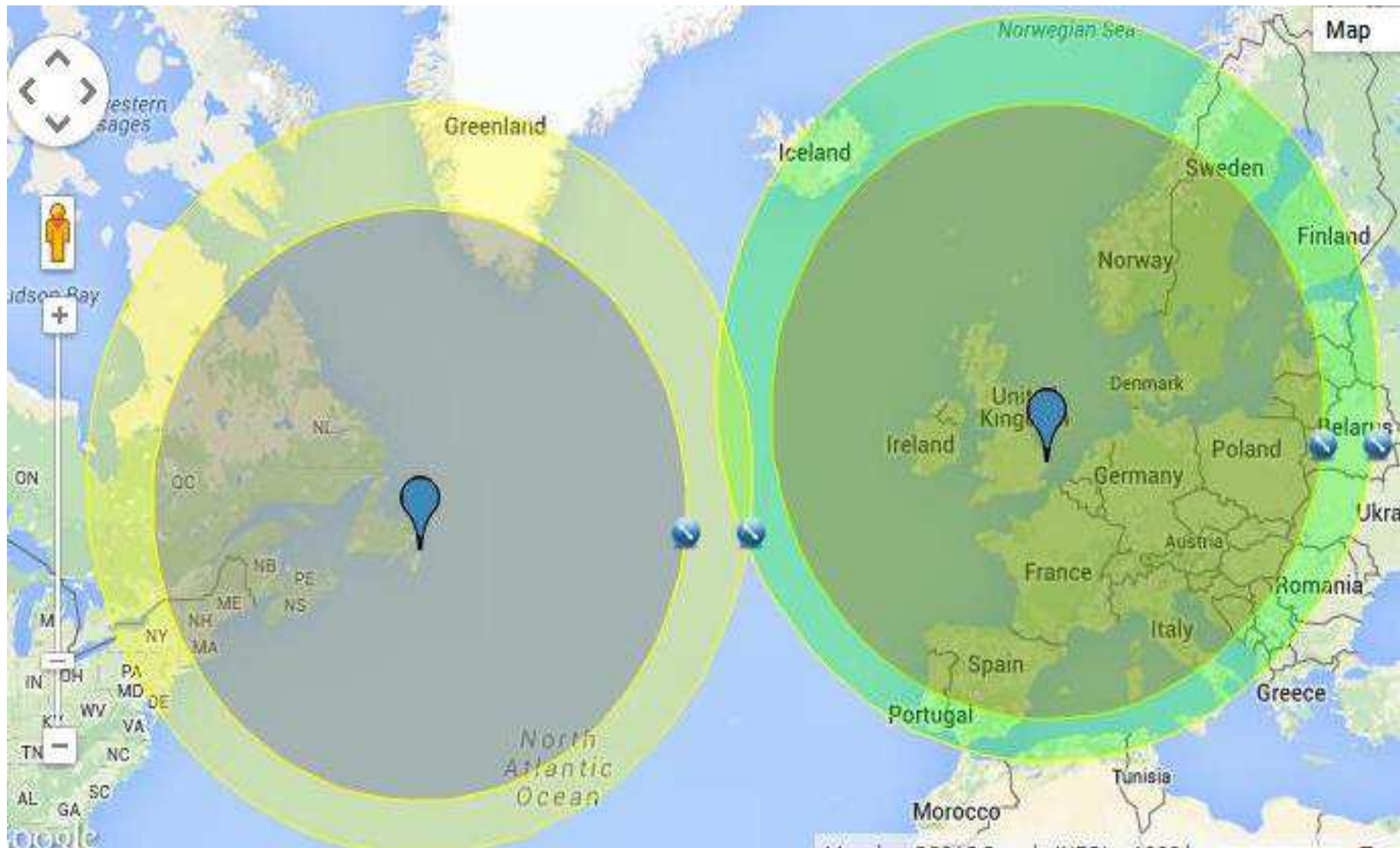
- Play Audio: Mon_140706_134130.WAV

- When decoded properly this reveals five or six 'bursts' of CQ VC1T

- Needless to say I put my linear into 'emergency warm up' and was calling 2 minutes later with a report.

- After four hours of calling I did not receive any more 'bursts'

Sporadic-E + Meteor Scatter ?



- There is a good possibility signals being propagated from Canada initially via sporadic-e being reflected off the Atlantic Ocean and further propagated by a meteor reflection on the European side.
- This slide shows the geometry of how I consider such propagation could take place. The Circles on the VO1 side are 1700 and 2100Km which are the average range for 144MHz e-s reflections and the circles around G4SWX are 1600 and 1900Km for meteor reflections as before.
- It is rare for 144MHz sporadic-e openings to last much more than 10 minutes between two fixed locations. In 10 minutes it is likely that you will get one random meteor coupling signals from further afield into that opening. To complete a QSO takes a minimum of 4 reflections but with 50-50% TX-RX duty cycle this means that a 2 way QSO needs the time required for 8 such reflections. During the short duration of a 144MHz sporadic-e event this is highly unlikely!

OK2KKW note: albeit highly unlikely, EI5FK, when he visited us, said that Irish fishermen have evidence about some reception of 150MHz FM Canadian coast ship communications.

E-S + MS or ISS Bounce?



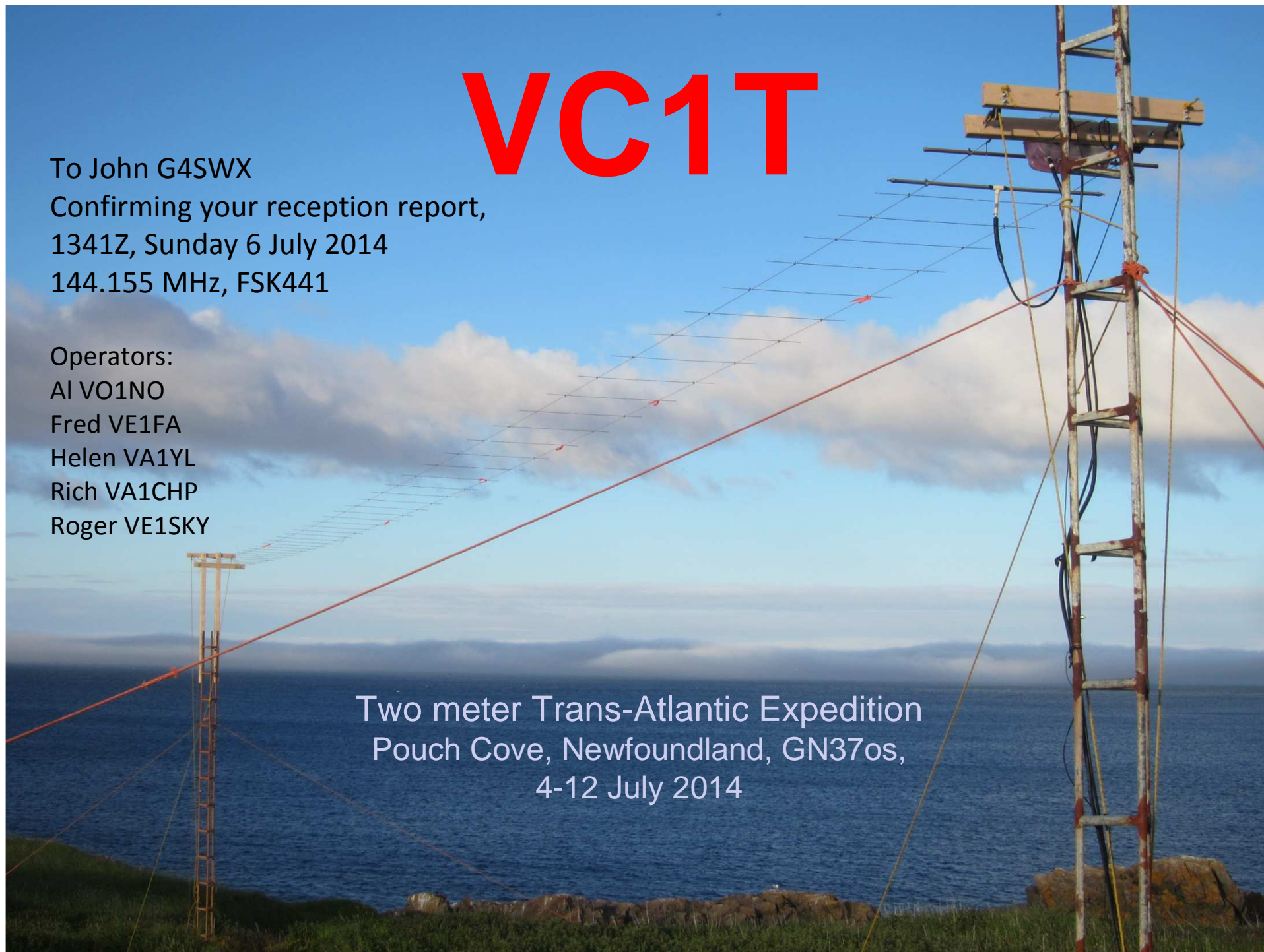
- There is some evidence to support the explanation that this reception of VC1T was as a result of meteor scatter combined with sporadic-e. The MUF over the path was at least 60MHz at that time as is evidenced by the Live MUF plots. The F5LEN tropo maps also indicate that the Atlantic was calm around the centre of the path which would facilitate a reflection from the sea.
- However completion of a 2 way QSO by combining meteor scatter and sporadic-e I regard as highly unlikely!
- It was also possible that this reception was caused by a reflection from the International Space station ISS which was over the Atlantic at that time. Detailed bi-static radar calculations show that such a reflection would be some 15-20dB weaker than the received signals. However after many months of analysis and subtracting transmitter drift (with the Icom IC-746 this is a big problem) the measured signal Doppler shift on the recorded signal closely matches a reflection or diffraction caused by ISS.

VC1T

To John G4SWX
Confirming your reception report,
1341Z, Sunday 6 July 2014
144.155 MHz, FSK441

Operators:
Al VO1NO
Fred VE1FA
Helen VA1YL
Rich VA1CHP
Roger VE1SKY

Two meter Trans-Atlantic Expedition
Pouch Cove, Newfoundland, GN37os,
4-12 July 2014



- So although not a not a two-way contact this is a confirmed reception of amateur signals from VC1T on 144MHz. I have no-doubt that this year's recent reception of the D4 Cape Verde Islands 144MHz beacon in the Caribbean will be followed up by a two way contact.
- However for crossing the North Atlantic my view is that as there are often strong tropospheric ducts reaching from Spain and Portugal reaching into the mid-Atlantic that favours meteor scatter plus tropospheric duct propagation as my favourite for the first trans-Atlantic 144MHz QSO.

Starting from JO80ei



1600Km = yellow 2000Km = white

- Here in the middle of Europe the possibilities of combining meteor scatter and tropospheric ducting are not so easy.
- The Google based tools to calculate the great circle path and the radial distance as can be seen in this slide can easily be found on the Internet.
- The possibilities of propagation to the Canary Islands EA8 are not good. The great circle path crosses over land all of the way to the Atlantic Ocean. The possibilities to the South West seem to be limited to Morocco CN8 or the Azores CU.
- However paths of up to 2600Km to Israel 4X are not only possible but highly likely as strong
- Tropospheric ducting exists over much of the Eastern Mediterranean for most of the summer months.

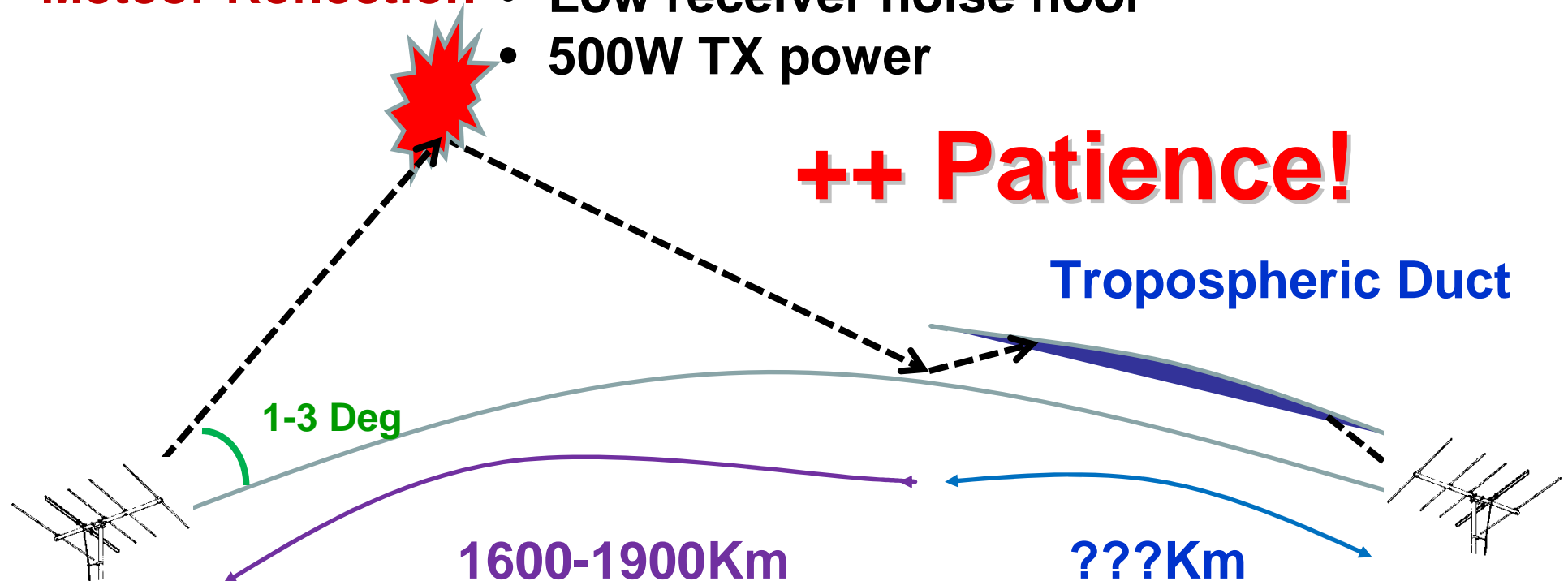
OK2KKW note: in that matter of tropo ducts: check OK1TEH report from 2005 year:

http://www.ok2kkw.com/00000104/kypr/cyprus_condx_en.htm

Outline MS+Tr Requirements

- High antenna gain at low angle 1- 3 Deg
- QTH on a hilltop is good!
- Or 2 stacked antennas
- 15-20m above ground is good
- Low receiver noise floor
- 500W TX power

Meteor Reflection



- What do you need to be a station on the meteor scatter end of such contacts?
- The most important thing is to be able to reliably work meteor scatter at elevation angles below 3 degrees. This means an antenna system with high gain at low angles 1- 3 Degrees. My four times sixteen element Yagi array is on a 20m high tower and works well on EME down to zero degrees elevation!
- However such a large system is not essential. A hilltop QTH such as that used by OE/DD0VF in JN47 to work EA8 via this mode is good. Else two stacked antennas, I have heard good signals from EA8 on two 17B2 antennas only 8m above ground level.
- What else is fairly essential is a low receiver noise floor and using a masthead preamplifier else you might not hear reflections from 100W stations.
- On transmit 500W is good, 1KW is better and even more makes life much easier!

What New 144MHz DX?

- Before August 2013 there were two MS QSOs >3000Km
- Since there have been ~50 MS+TR QSOs to EA8 >3000Km
- I have been lucky completing >10 such QSOs
- Now looking for contacts with D4 and 4X via tropo + MS?
- Trans-Atlantic tropo + MS from EA1 to VO1 is possible
- Dual mechanism propagation presents exciting new challenges on 144MHz.

Records can be broken:

‘with a little help from a few other hams’

- Domingo EA8TJ
- Fernando EA8TX
- Peter PA3BIY
- Dick PA2DW
- Frank PA4EME
- VC1T team
- + many others!



Thank You For Listening

Any Questions?

G4SWX

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