DX on VHF and above
(tailored to Scandinavia)

Stefan Heck - LA0BY

Contents

- What is DX on higher bands ?
- Presentation of propagation modes
  - Mechanisms and typical signatures
  - Some examples (visual, audio)
  - Summary wrt location at 60º North
- Some highlights on own activities (if time)

What is DX on VHF and up?

Definition of DX

- Other continents or countries, QRB > 500 km?
- What one cannot reach every day?
- Perhaps different from band to band?

>>> distance – unusual

Common features (with exceptions)

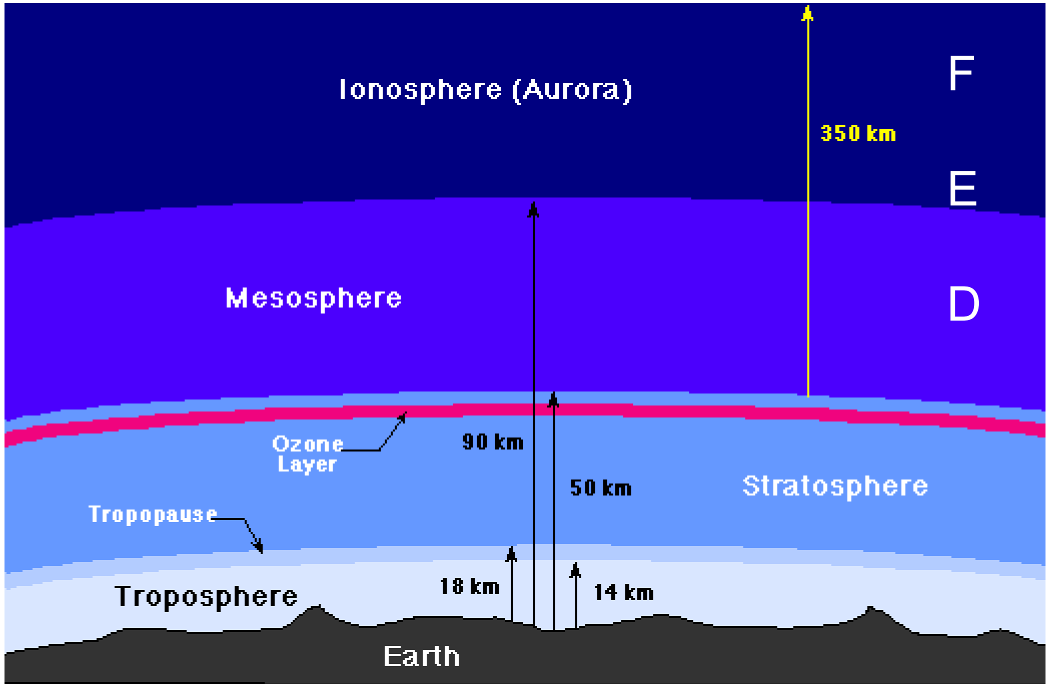
- Weak signals, mode either SSB or CW

Why hunt for DX?

New SQR!

More fun!

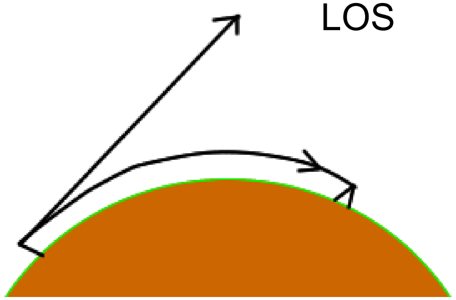
The layers involved in propagation on VHF and higher



- VHF: 6 m, 4 m, 2 m >>> Tropo, E, F
- UHF: 70 cm, 23 cm >>> Tropo (+ some F)
- SHF: > 13 cm >>> Tropo

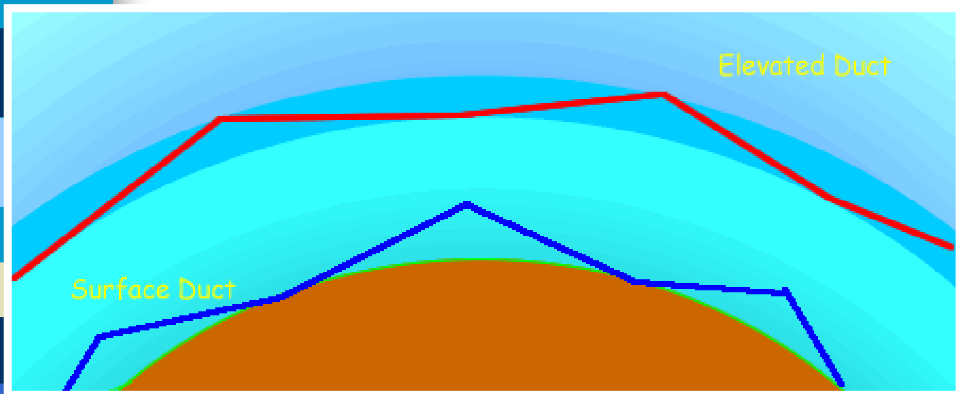
- **Focus in this presentation is on 144 MHz**

Tropospherical propagation (Tropo)



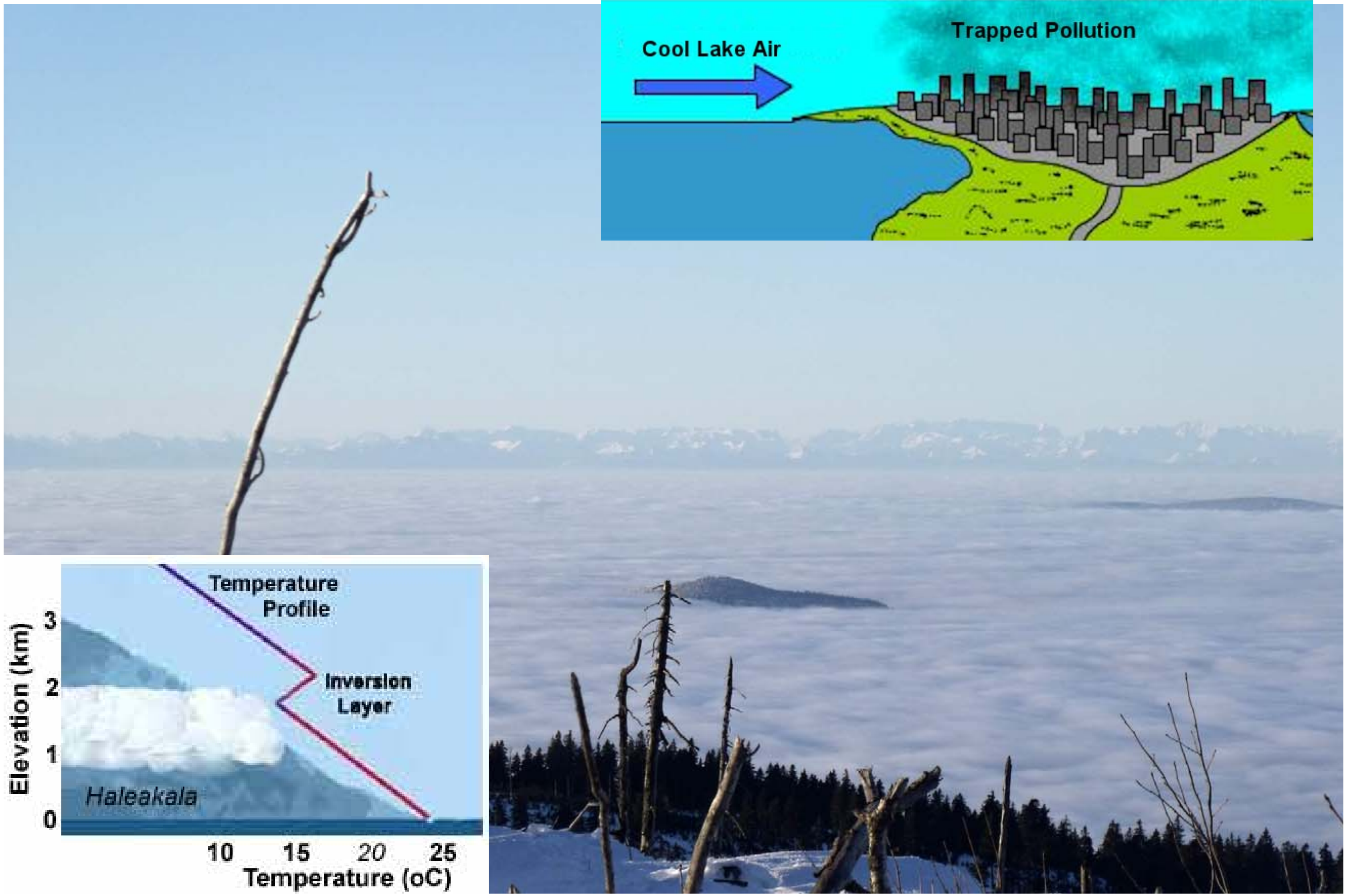
- Common on all bands
  - ”Flat band”
  - Line-of-sight (LOS) on µW
- Hilltop gives larger radius, but not enough for DX

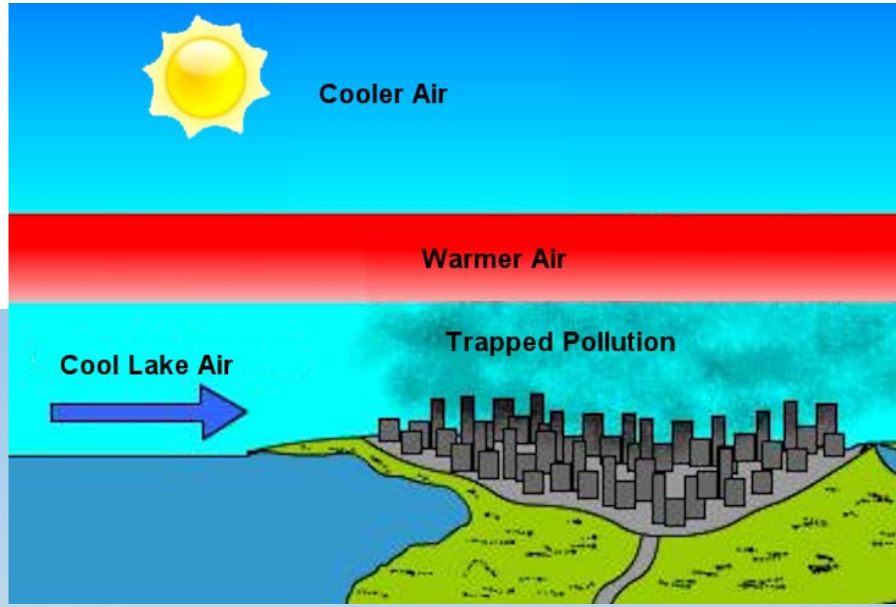
Unusual conditions: Inversion/Ducting



- Temperature inversion
  - Layers with different refraction indices bend signal
  - Depends on frequency
- Duration: hours to days
- Distance < 4000 km?

The look of DX





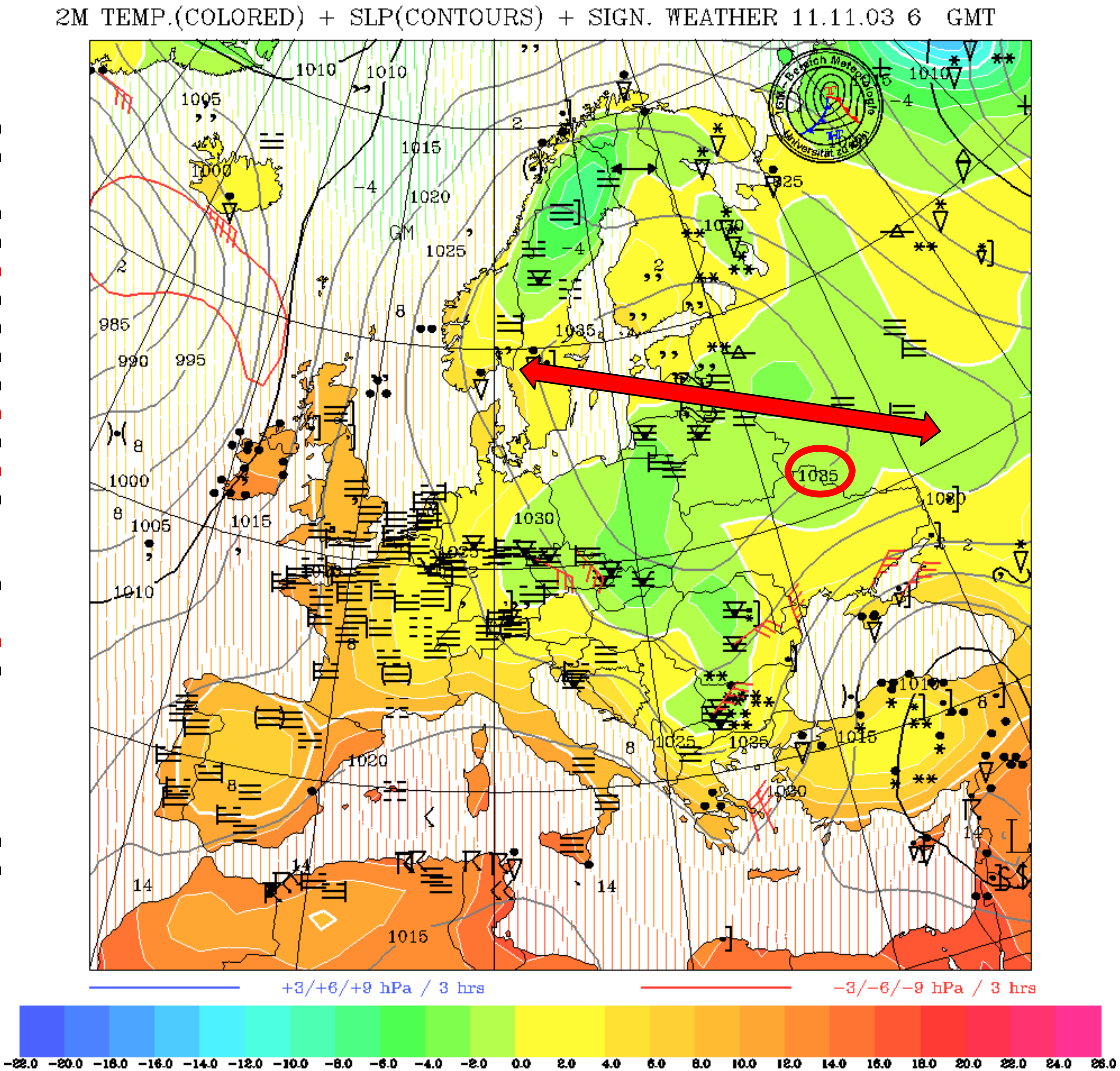
Tropo analysis with isobar maps

LA0BY in JO59IX - 144 MHz

RA1TT	KO68XJ	1329 km
RW3TJ	LO16XG	1973 km
SP4JWD	KO03FR	912 km
RA3AQ	KO85SP	1648 km
RK3AF	KO85QR	1634 km
RW3TI	LO16WG	1968 km
RX1AX	KO59EW	1091 km
UA3ARC	KO85SO	1650 km
RA3LBK	KO65QA	1453 km
RZ1AP	KO49VW	1059 km
RW3TJ	LO16XG	1973 km
RU3ACE	KO95KG	1742 km
UA4UK	LO14MA	2043 km
UA3AOG	KO85SR	1643 km

LA0BY in JO59IX - 432 MHz

RX1AX	KO59EW	1091 km
OH1XT	KP01UK	619 km
UA3ARC	KO85SO	1650 km
RA3AQ	KO85SP	1648 km
ES5PC	KO38HJ	921 km
OH6QR	KP22BN	771 km
ES2RJ	KO29JN	788 km
LY2SA	KO14LL	955 km
ES2NA	KO29JL	790 km
LY2BAW	KO25KA	1007 km
LY3OD	KO24OR	1044 km



Troposcatter

- Reflection from minor irregularities in the troposhere (mini-inversions?)
- Works on all bands over distances up to ca 1000 km, but unstable and much fading
- Difficult to distinguish from ordinary Tropo
- Requires high EIRP

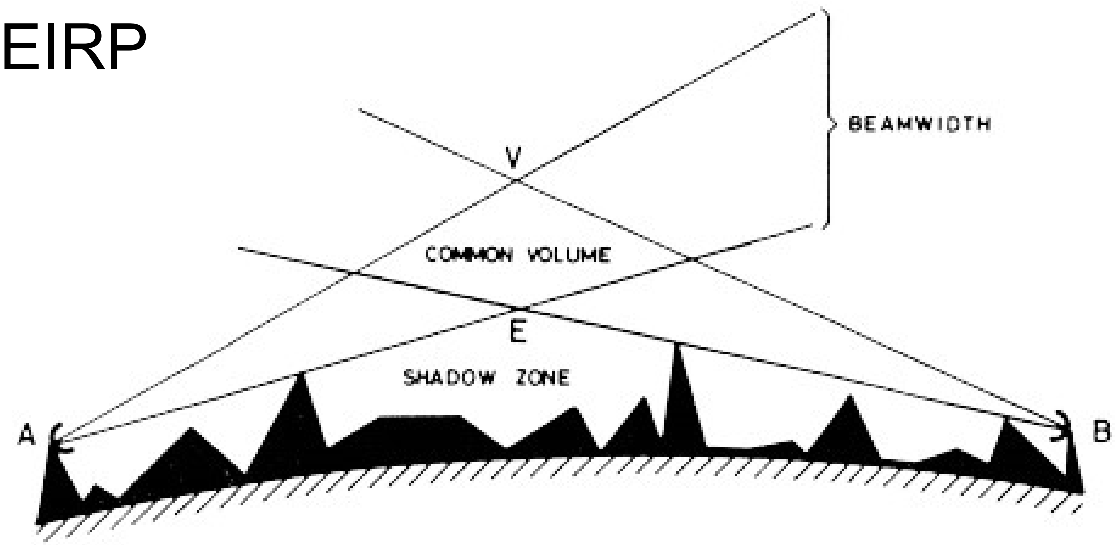
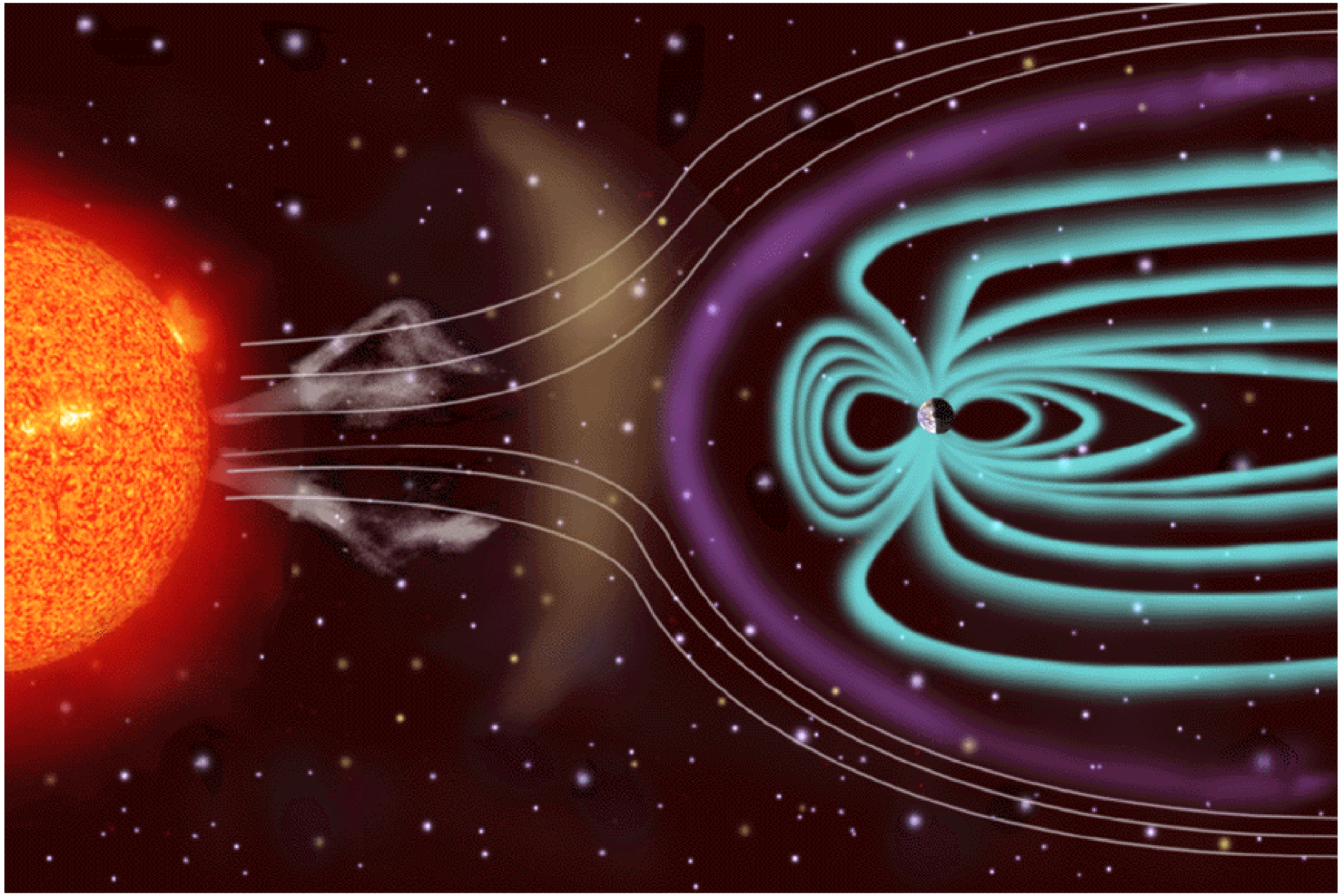


Fig. 4.4 Profile of a typical troposcatter path.

Roda, Troposcatter Links

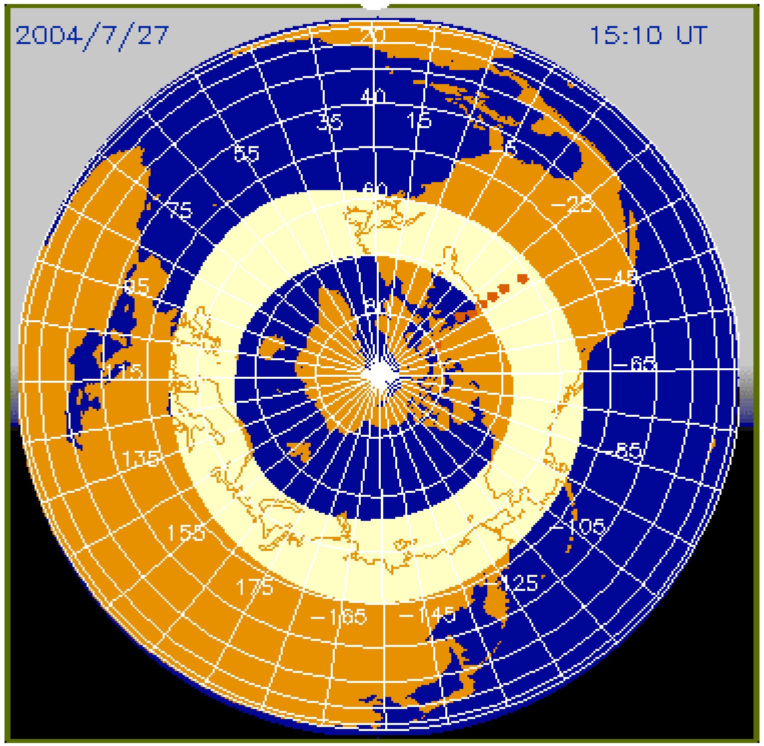
Aurora – driven by the Sun

- Solar wind pushes highly energetic particles into the polar ionosphere, if the Earth's geo-magnetic field is favourable (B_z oriented southwards)



Polar light = visual manifestation

- Area of ionisations resembles an oval around the geo-magnetic poles and generates Polar lights
- The southern extension of the polar light depends on the intensity of the solar wind, and the time of day



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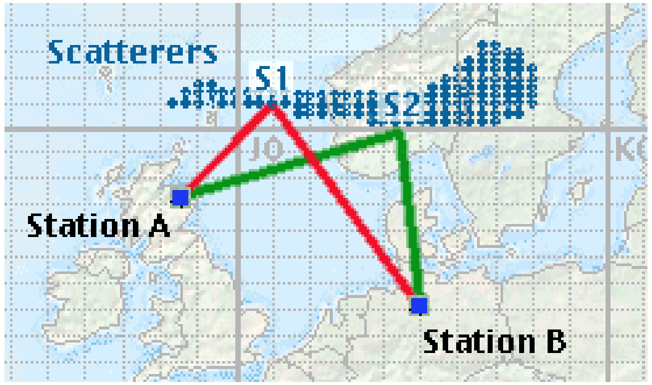
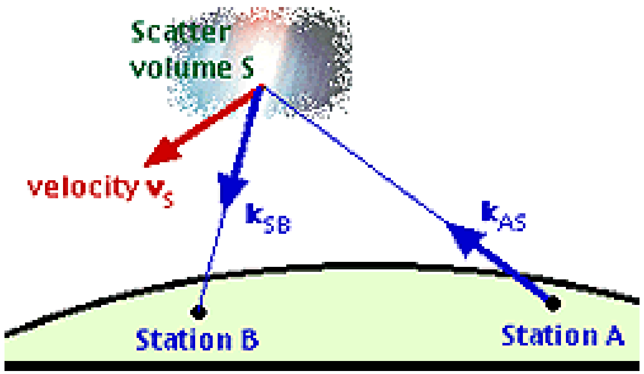
Aurora - reflecting radiowaves

- Radiowaves coming from South are reflected in incoherent manner (leads to phase distortion!)

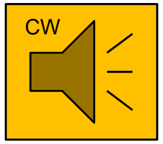


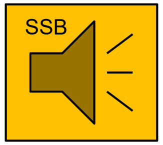


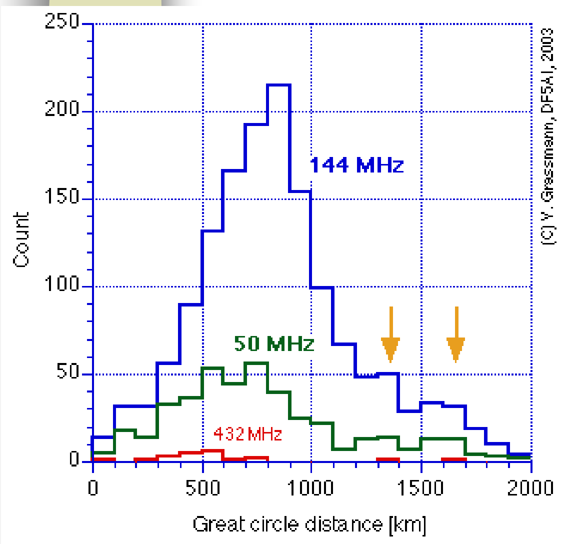
- Signal from A is received by B through reflections from different areas
- Doppler shift is observed if the Polar light is moving
- The frequency of Aurora changes with the Solar cycle

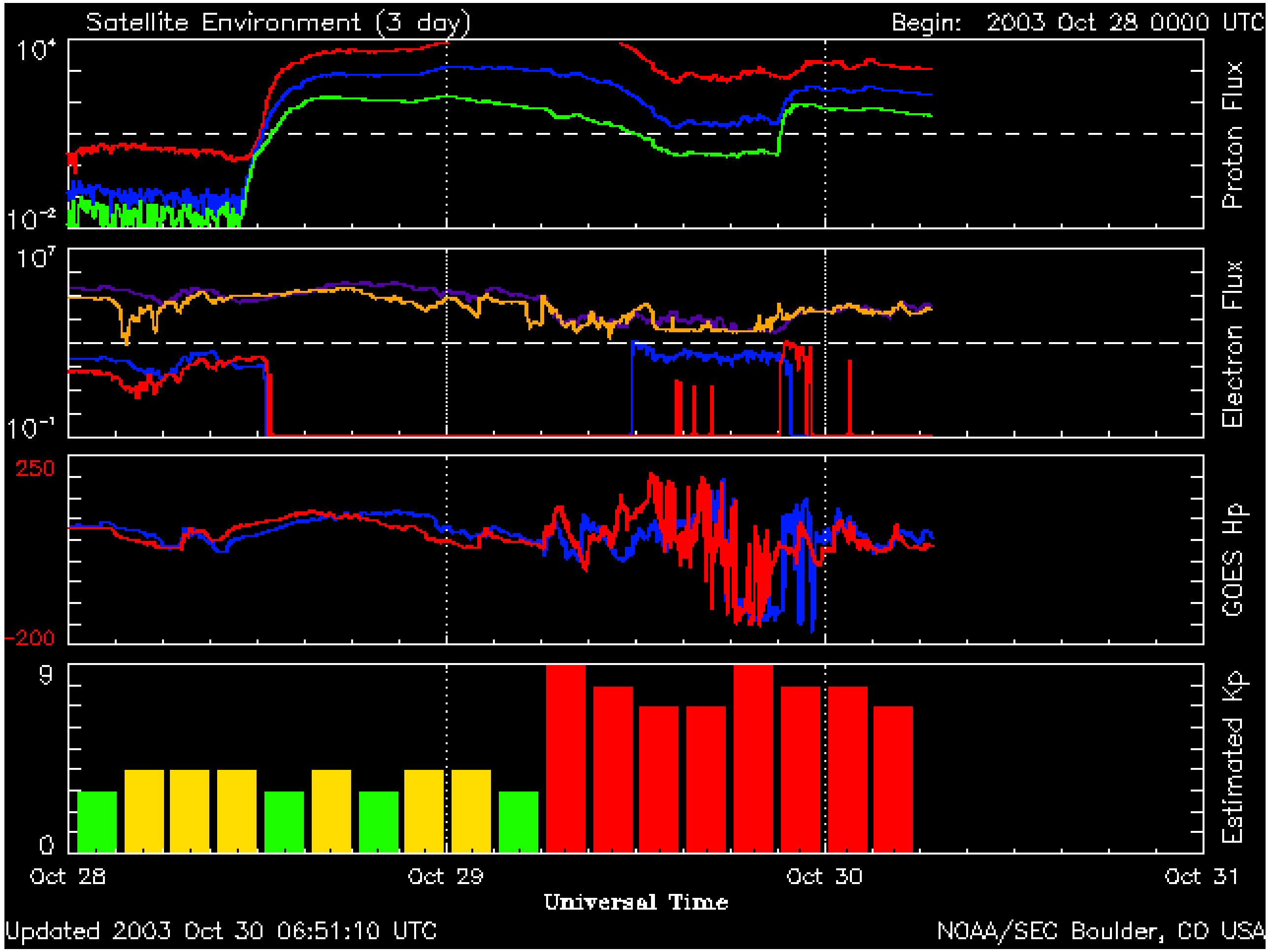
Aurora

- CME on the Sun releases particles
- Geo-magnetic field becomes distorted
- K-index > 5 indicates radiation storm
- Aurora in Scandinavia if K>4









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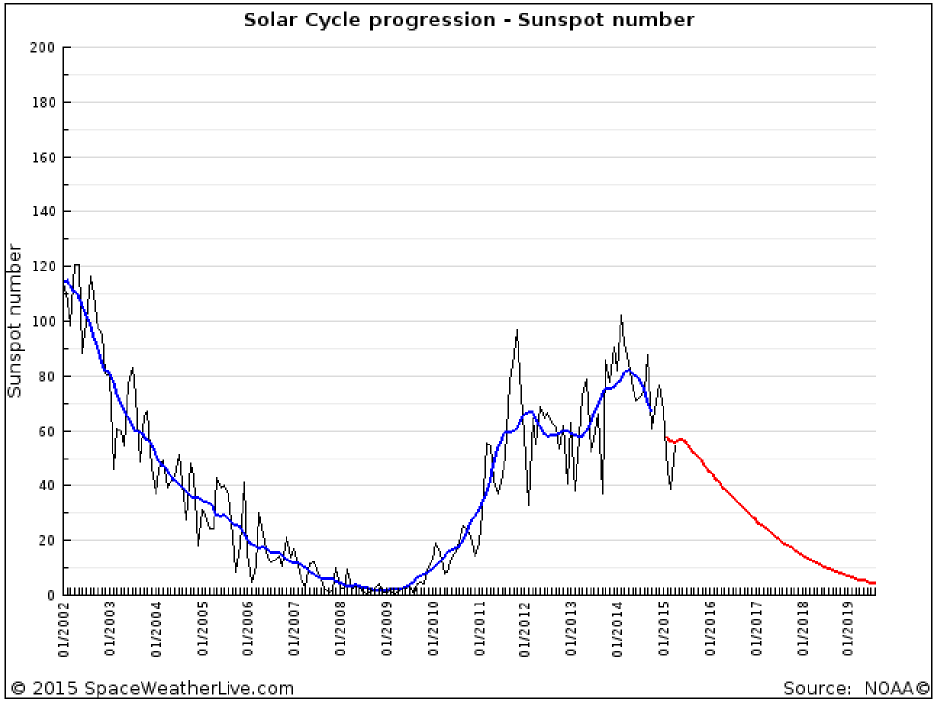
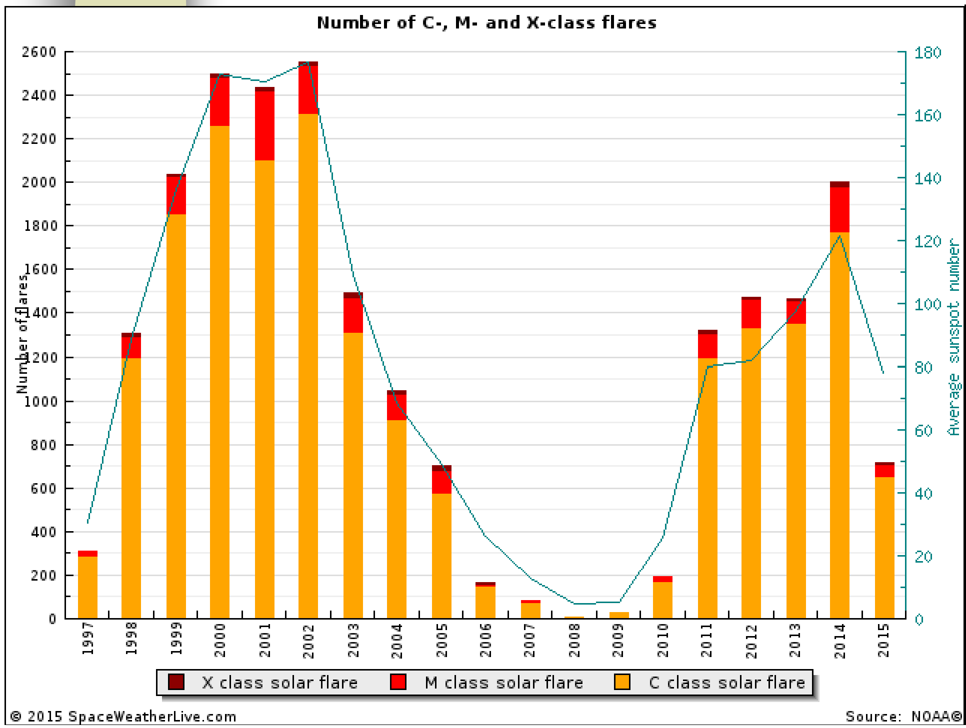
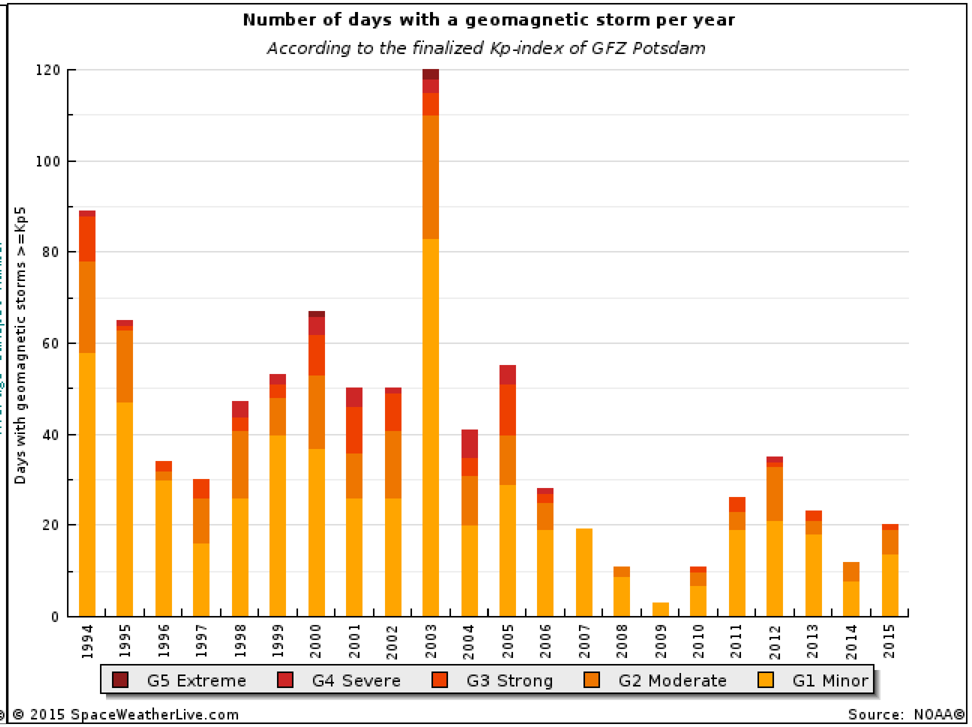
Solar Cycle 24

- We have passed second peak
- Clearly weaker than previous cycles

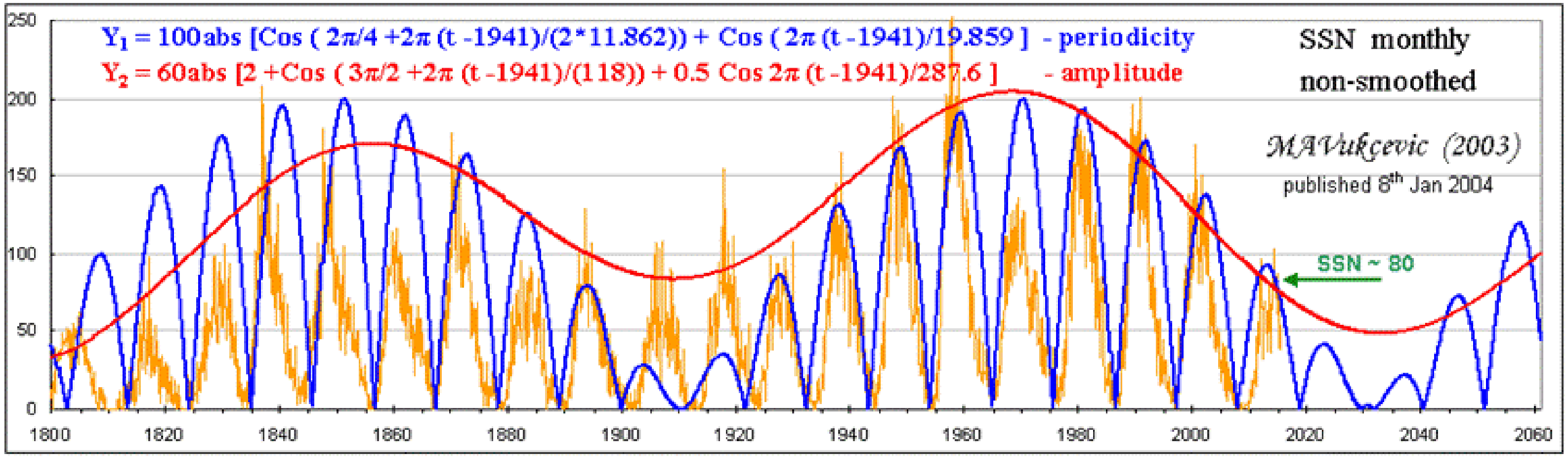
Source: SpaceWeather / NOAA



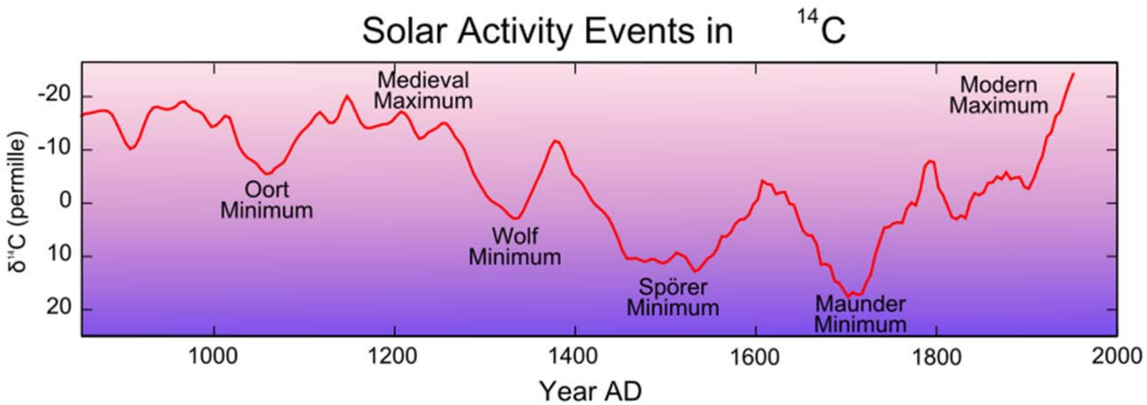




Will Aurora ever be like before?



- Analysis by Vukcevic on SSN: poor for next 2 periods
- Some scientists even talk about a Maunder minimum with almost no sunspots for 50-70 years



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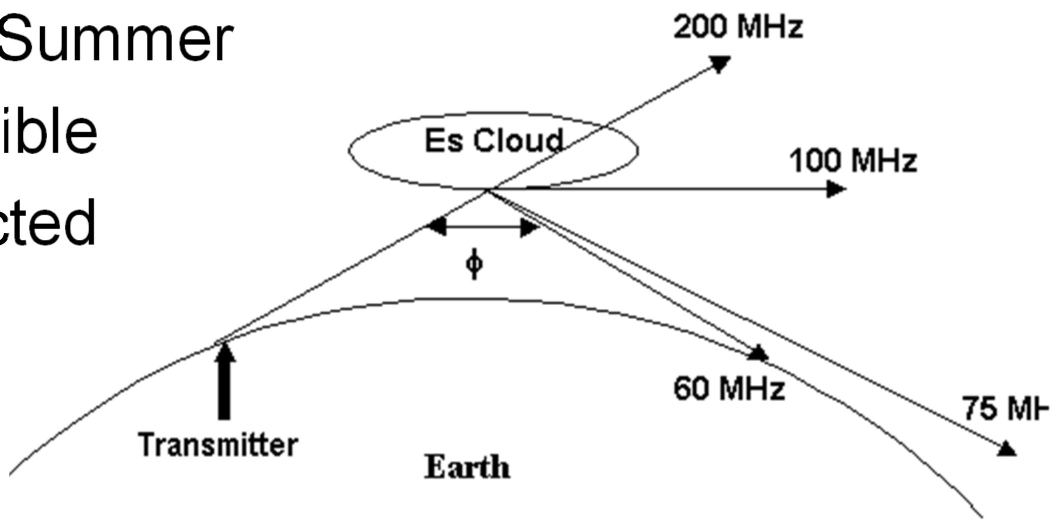
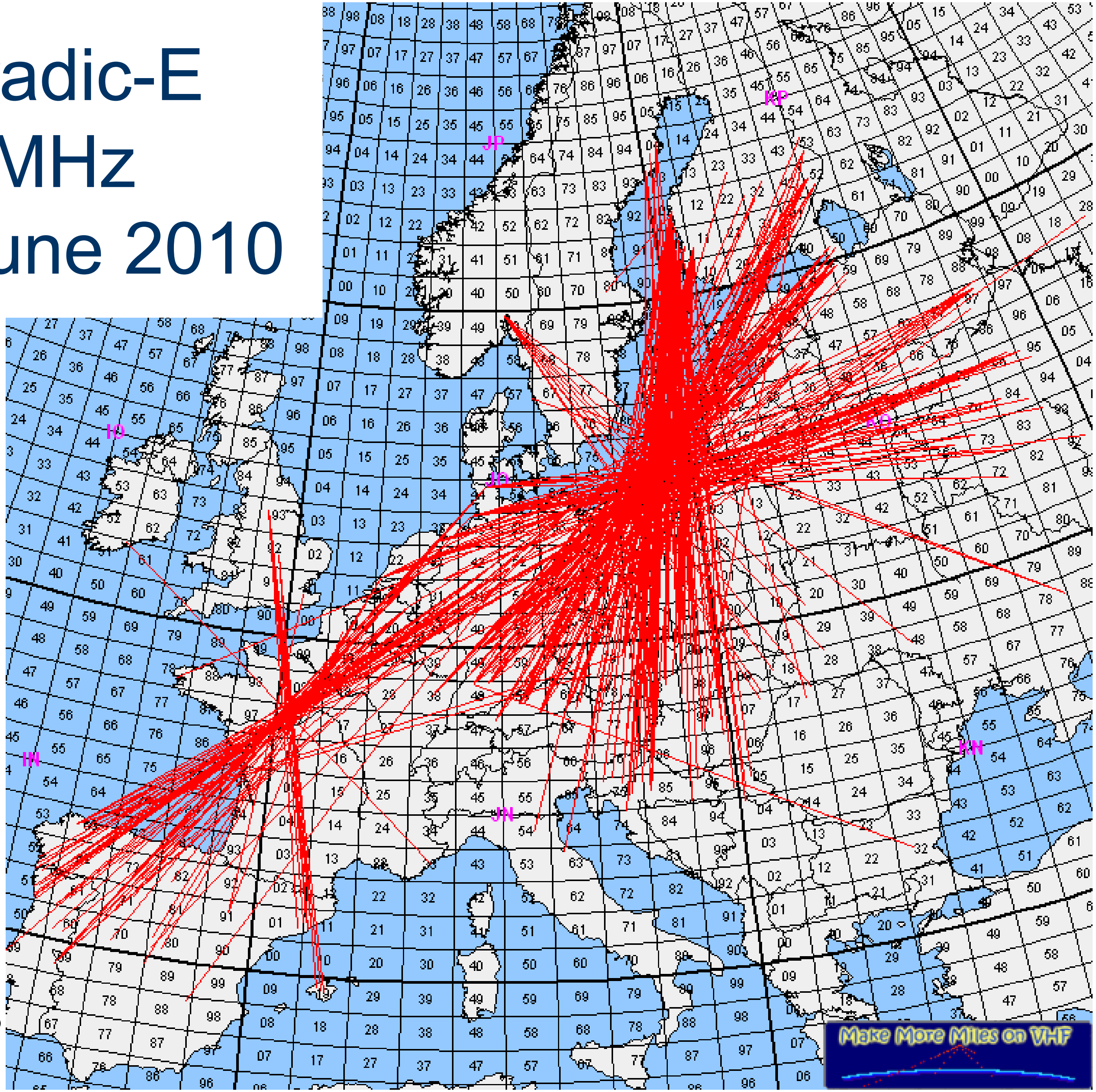
Sporadic-E (Es)

- Intense solar radiation generates local ionisations in the E-layer which act like solid mirrors
- Coherent reflections, resulting in strong and undistorted signals
- Usual on 50 MHz and 70 MHz, but rare on 144 MHz
- MUF is rising with ionisation density (plasma)
- Lasts from minutes to hours
- Happens during Summer
- Dual-hop is possible
- Cannot be predicted



Sporadic-E
144 MHz
20 June 2010



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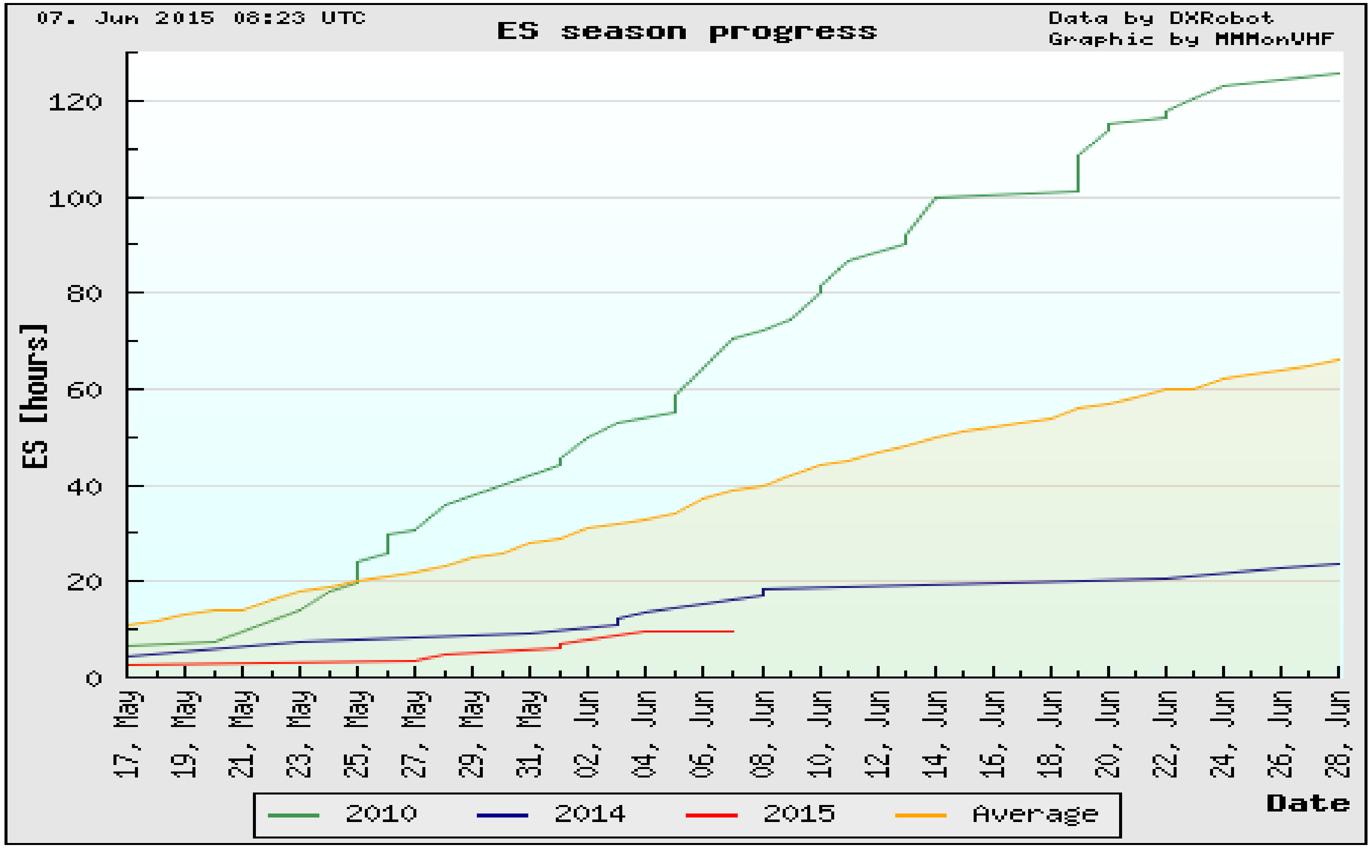
Sporadic-E season 2015

- Number of Es-openings was quite low in 2014, but seems to be even lower in 2015
- See comparison by PE1NWL on MMMonVHF:



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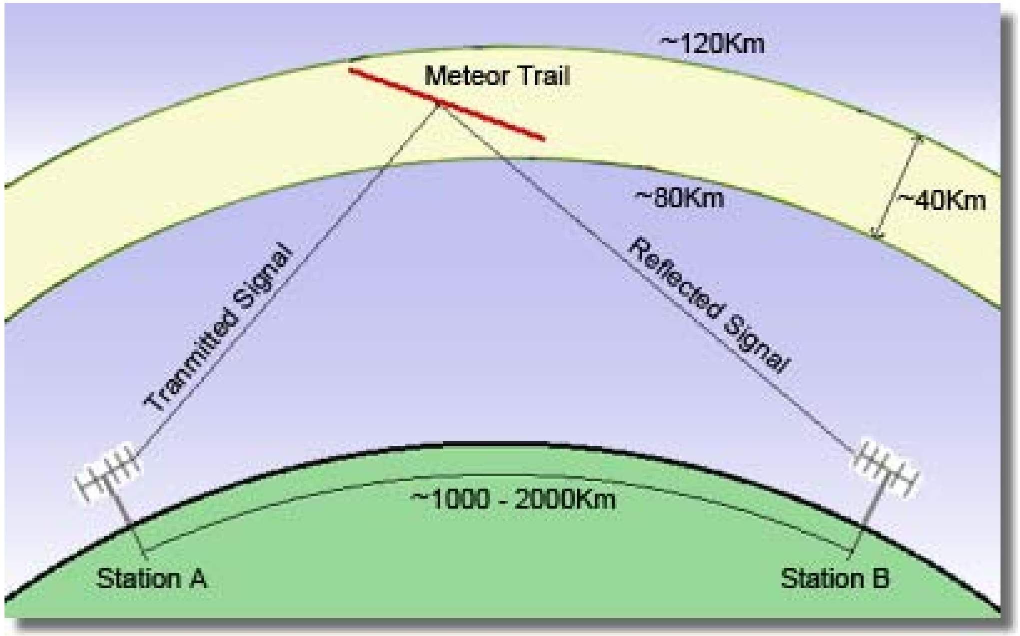
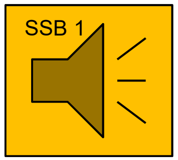
Meteorscatter (MS)

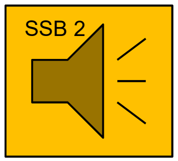
- Galactic dust is caught by the Earth
- Dust burns in ionosphere on its way to the surface
  - Visual observation (”shooting stars”)
  - Generates small and short-lived ionizations acting like mirrors for radiowaves
- Maximum distance 2200 km, depending on particle velocity (=> altitude of ionisation)

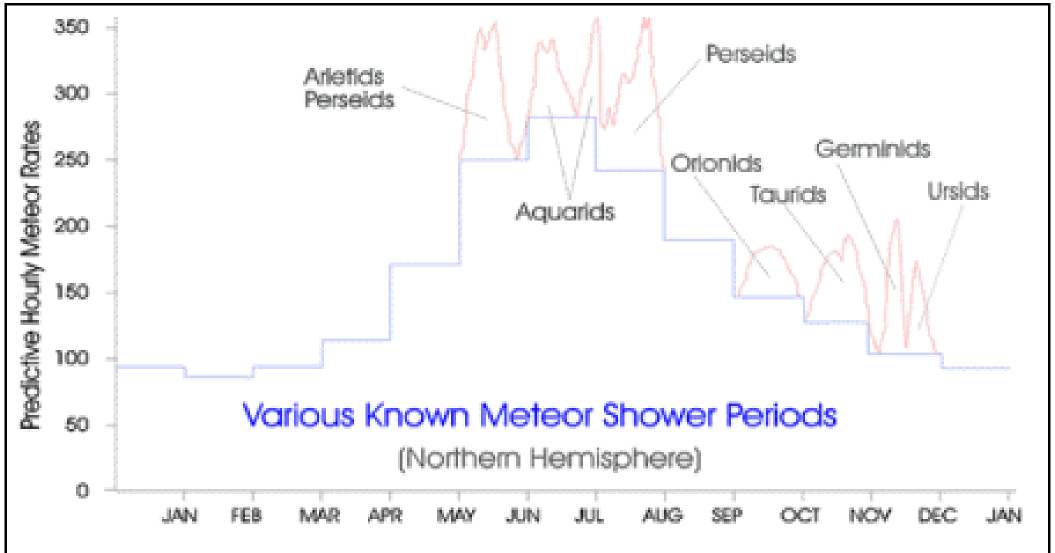


Meteorscatter (MS)

- Earth catches dust all time, but at certain times it passes through belts with remnants of comets
- Useful on frequencies from 50 MHz to 432 MHz, but used mostly on 144 MHz (work/activate rare squares)
- Duration of reflection is between 0,1s to 2 min
- TX/RX periods should follow agreed sequence
- Modes used
  - FSK441 (WSJT)
  - SSB in showers







Seasonal Variations of Meteor Rates

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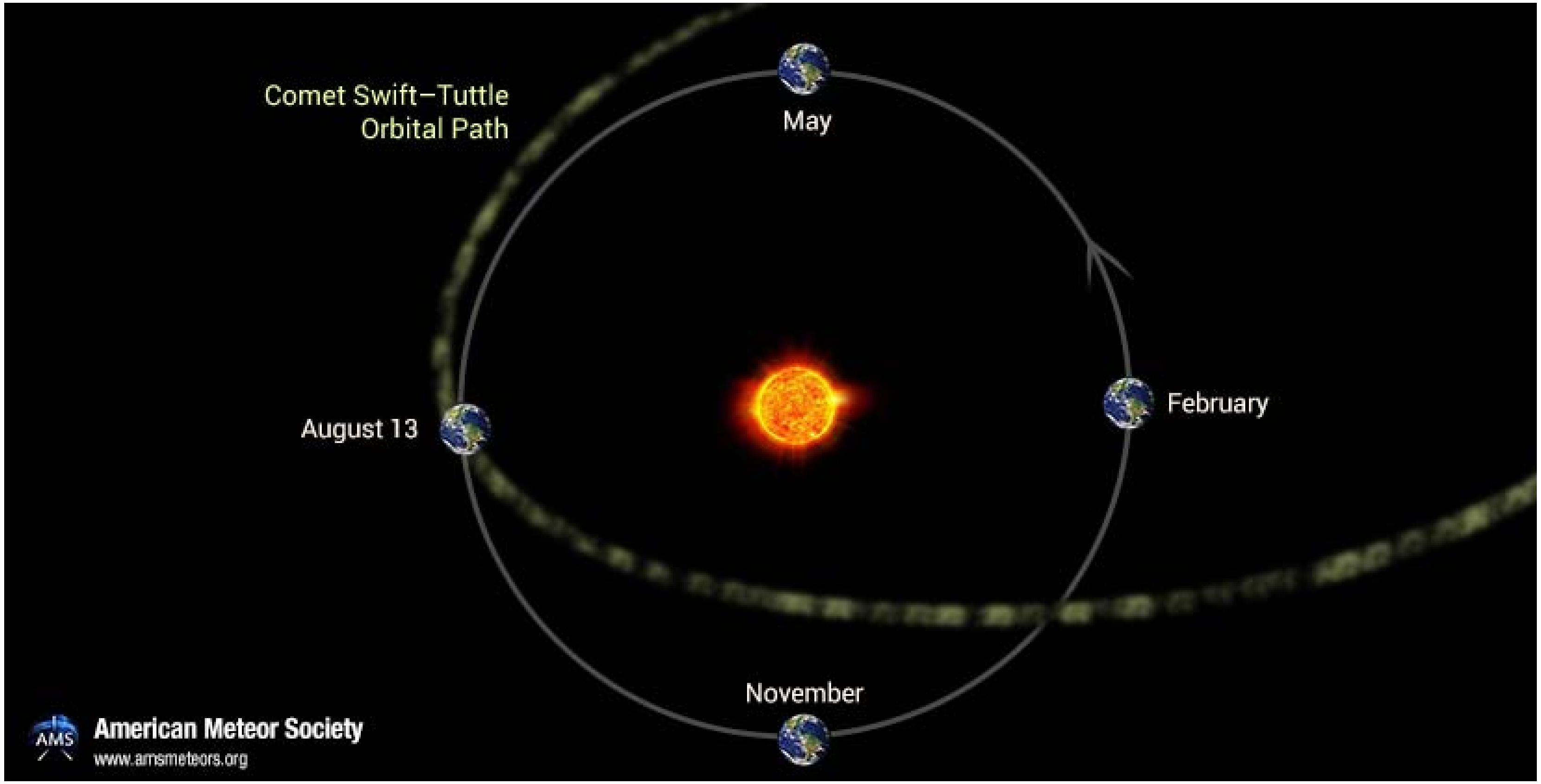
Perseids – why on same day?



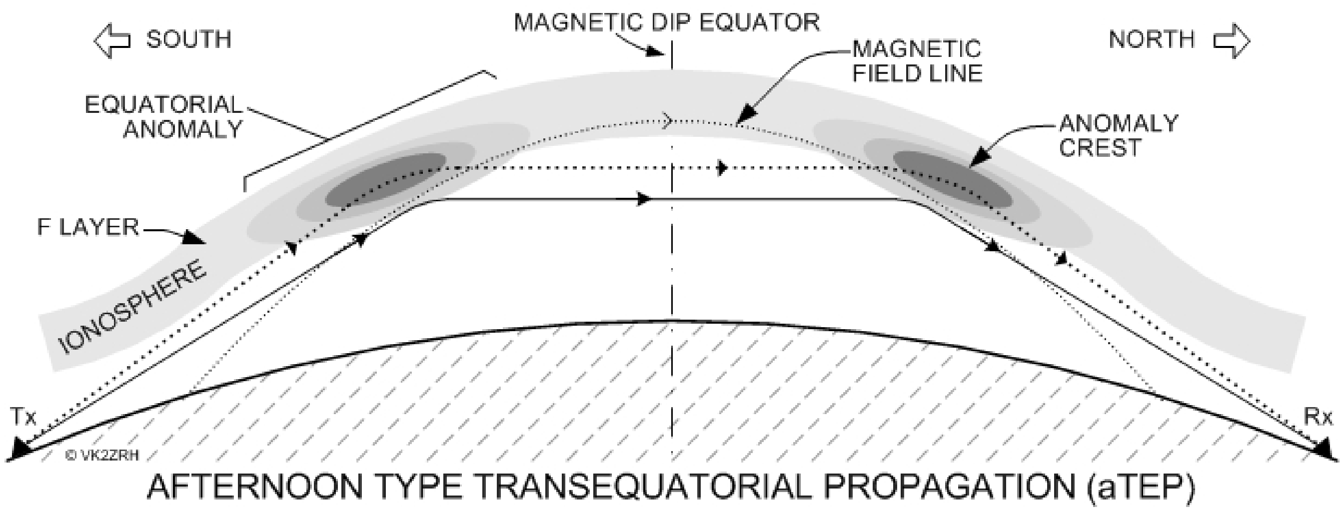
- Earth passing through trail of comet Swift-Tuttle

Perseids - Radiant

F2

- Standard propagation mode on HF
- Sometimes observed on VHF (50 MHz) around maximum of solar cycle

- Trans-equatorial Propagation (TEP)



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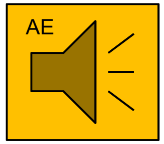
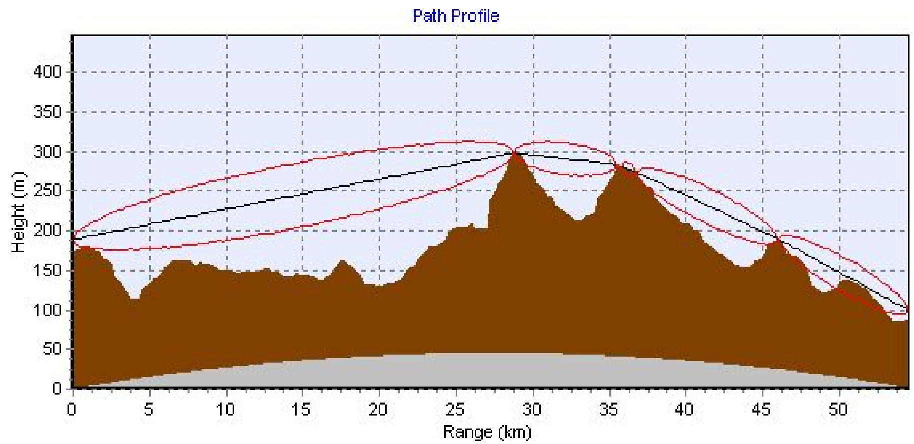
Other propagation mechanisms

- Rainscatter
  - Reflection of microwaves > 2,3 GHz from electrically charged clouds during thunderstorms
- Aurora – E
  - E-layer developes after strong Aurora



- Ionoscatter
  - Forward scatter through low-density ionisations
- Field-aligned Irregularities (FAI)
  - Aurora-like Backscatter after strong Sporadic-E events
- Refraction on edges
  - Trans-Alp Propagation
- PMSE?



Propagation mechanisms - summary

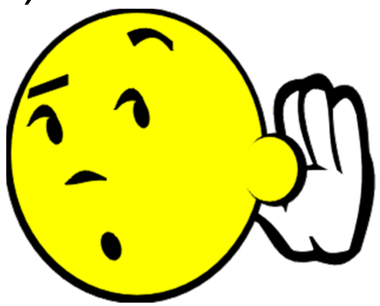
Propagation	Frequencies	Mode	PWR *	Distance #	Days annually in Oslo		
			W	km	6 m	2 m	70 cm
Tropo	50 MHz - 24 GHz	all	10	< 800	always		
Ducting	144 MHz - 24 GHz	all	1	< 4000	5-15?	5-15	10-20
Troposcatter	144 MHz - 10 GHz	CW, SSB	100	500-1000	always		
Rainscatter	5,7 -24 GHz	CW	(>1)	(200 - 1000)	never (only on SHF)		
TAP	144 MHz	SSB, CW	50	300 - 1000	never?		
Sporadic-E	50 - 144 MHz	all	10	800 - 3500	40-80	3-10	never
Aurora	50 - 432 MHz	CW (SSB)	50	2000	5-30	5-30	1-10
Aurora-E	50 - 144 MHz	CW, SSB	50	800 - 2200	10	5	never
FAI	144 MHz	CW, SSB	100	800 - 2000	never?		
Meteorscatter	50 - 432 MHz	FSK, SSB (CW)	100	500 - 2200	300	300	10
Ionoscatter	144 MHz	CW, SSB	500	800 - 2000	3-5?	1-5	never
F2	50 MHz	all	(10)	(3000 - 20000)	0-10?	never	never
TEP (F2)	50 - 432 MHz	CW, SSB	100	6000 - 10000	never		

Tropo E-layer F-layer

How to discover DX propagation?

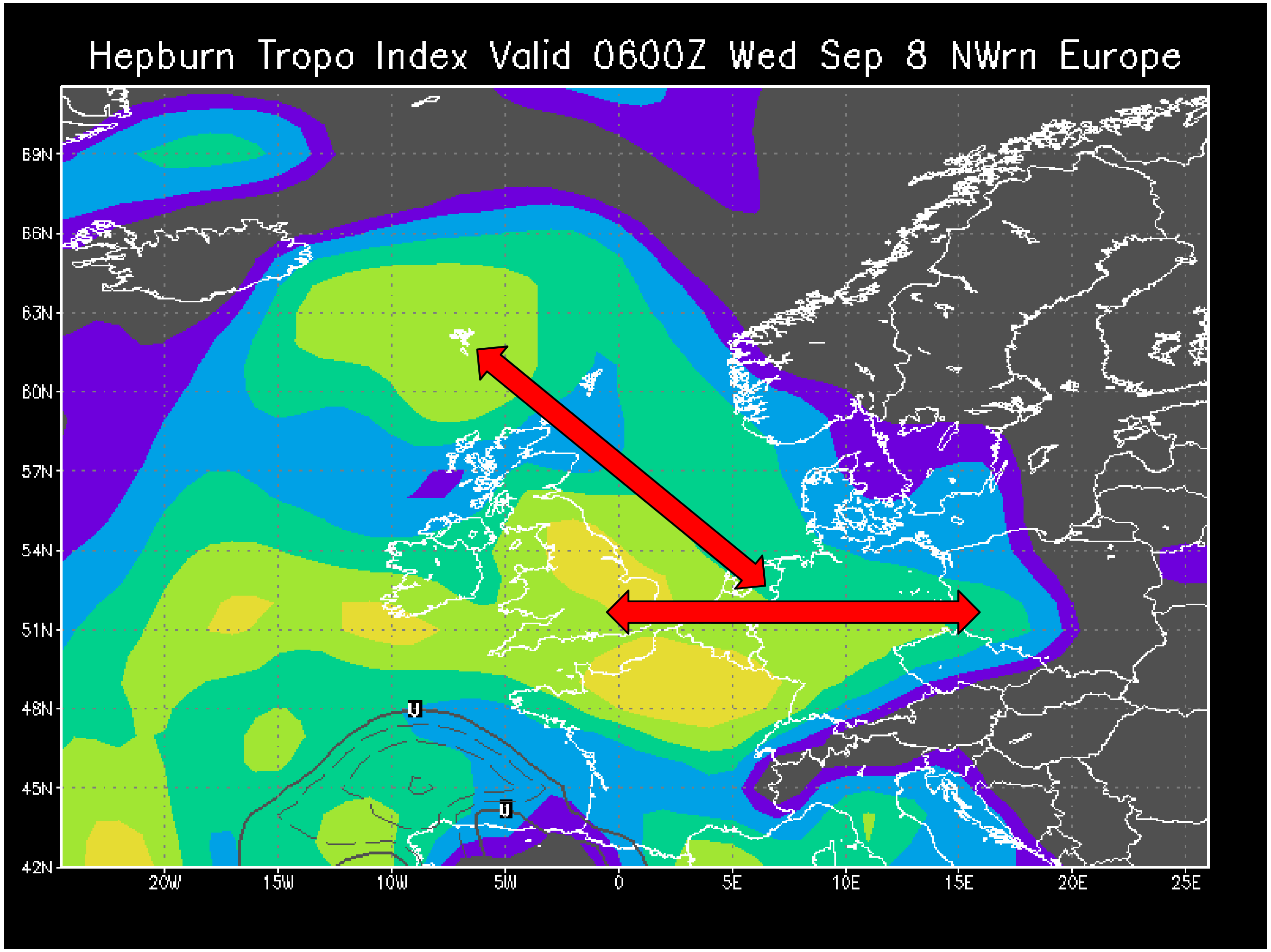
- «I have this fancy radio but every time I listen on VHF it is just noise»

- DX on higher bands requires to be in the right place at the right time!
- Follow what is going on
  - Weather maps (or just look out of your window)
  - Internet tools => DX-Cluster
  - Don’t forget to monitor the band of interest!



Tropo ducting

- Hepburn: Map showing forcast of inversions



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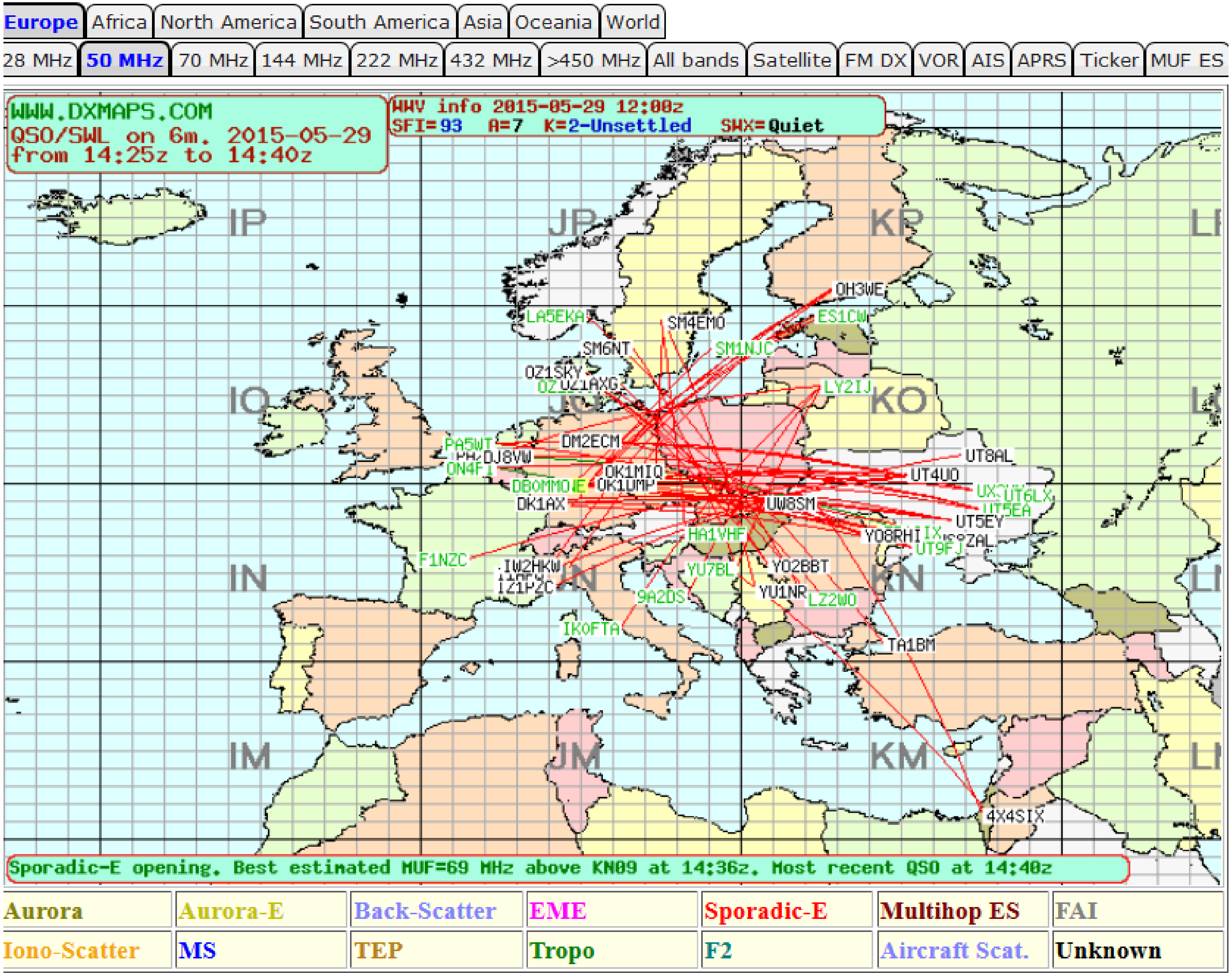
DX real-time Maps by EA6VQ



Useful Internet resources

- Propagation phenomena: http://www.df5ai.net/
- DX-Maps: http://www.dxmaps.com/spots/map.php

- Tropospheric Ducting forecasts
  - Hepburn: http://www.dxinfocentre.com/tropo_nwe.html
  - F5LEN: http://cluster.f5len.org/index.php?p=tropo
- Space Weather: http://www.spaceweather.com/
- NOAA Solar Environment: http://www.n3kl.org/sun/noaa.html
- Kiruna magnetometer: http://www.irf.se/Observatory/?link[Magnetometers]=Data/

Some words about myself

- QRV on VHF since 1979, first from DL (DF9PY)
- Activity from > 60 squares (mainly DX-peditions)

- I do <u>NOT</u> have a very big station
  - 50 MHz: 100 W into 2-ele yagi
  - 70 MHz: 25 W into 3-ele yagi
  - 144 MHz: 180 W into 2 x 9-ele yagi
  - 432 MHz: 120 W into 2 x 13-ele yagi
  - 1296 MHz: 15 W into 23-ele-yagi
  - 10 GHz: 1 W into 48 cm dish

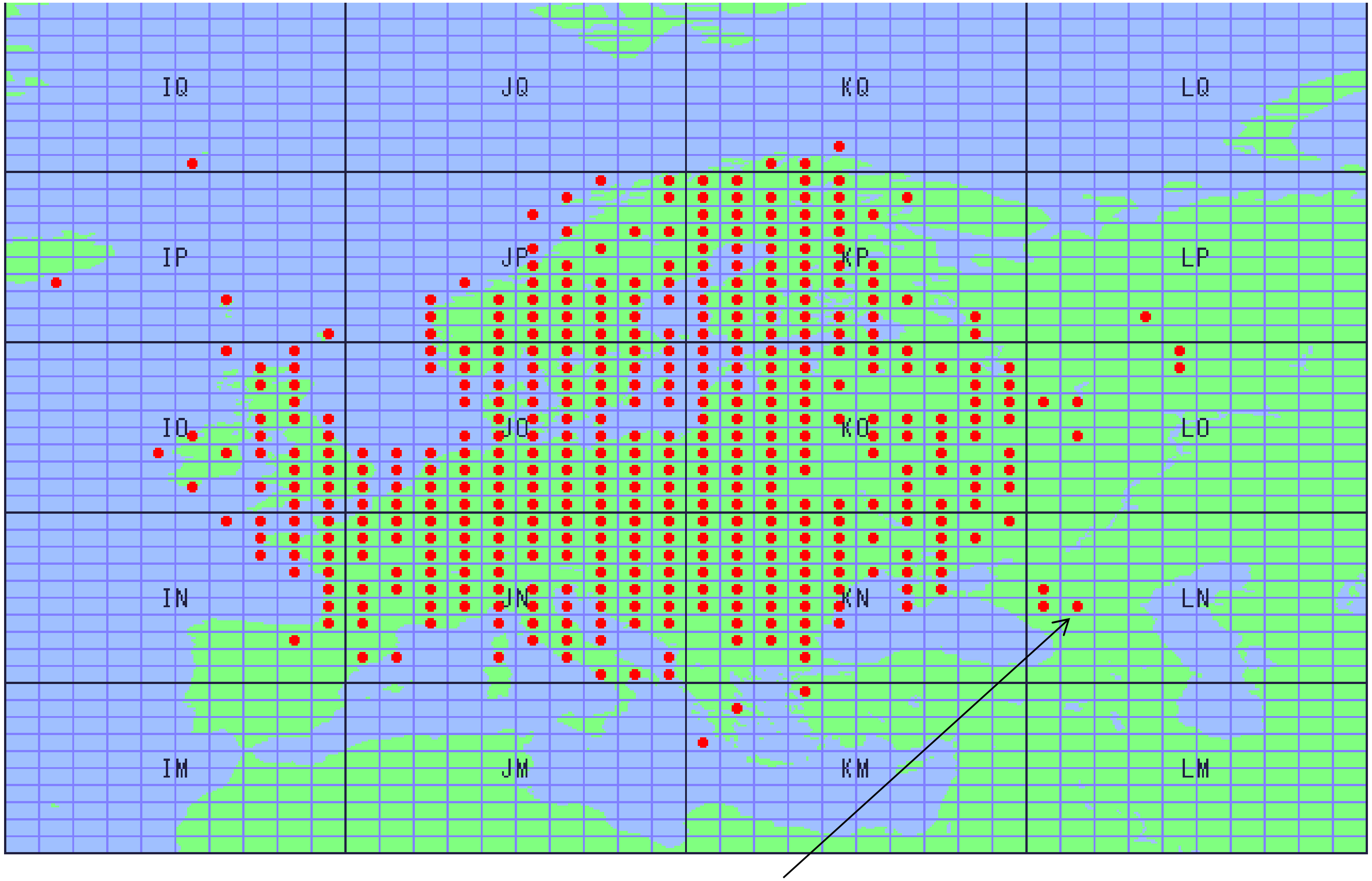
LA0BY – JO59IX

- Tryvann / Oslo
- Accessible to the public by car
- 500-520 m asl
- Radio horizon 800 km on 2 m, 700 km on 70 cm
- Interference
  - commercial TX
  - AR repeaters
  - Radar (23 cm)

LA0BY 144 MHz

Status 2012

Squares worked from JO59FW/IX – total > 442

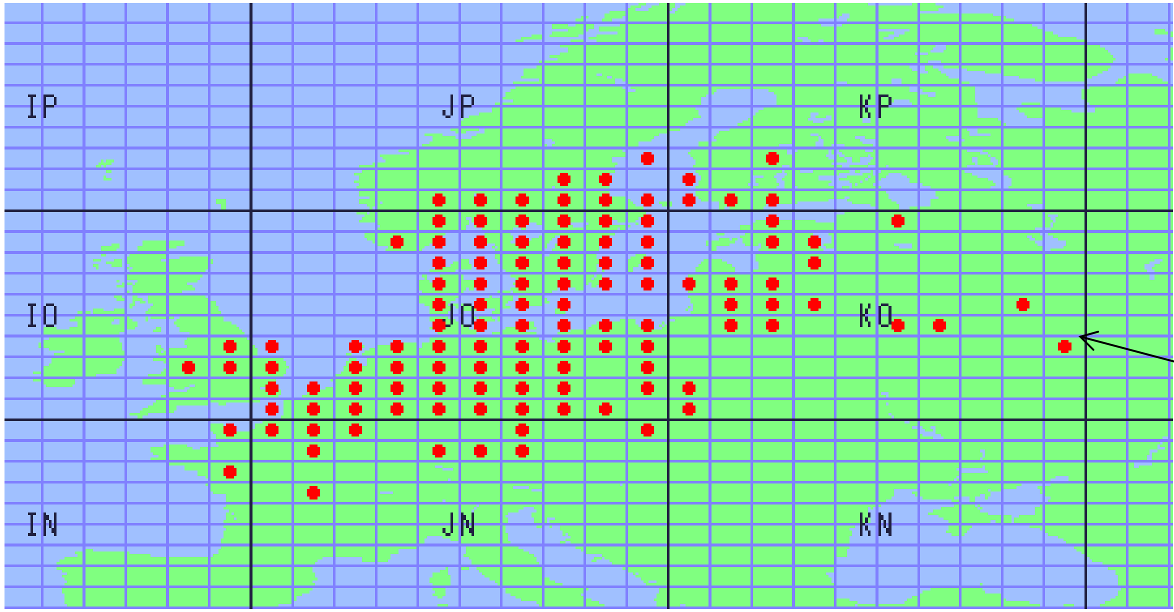


ODX: UA6EC LN14AE 2725km (Es)

LA0BY 432 & 1296 MHz

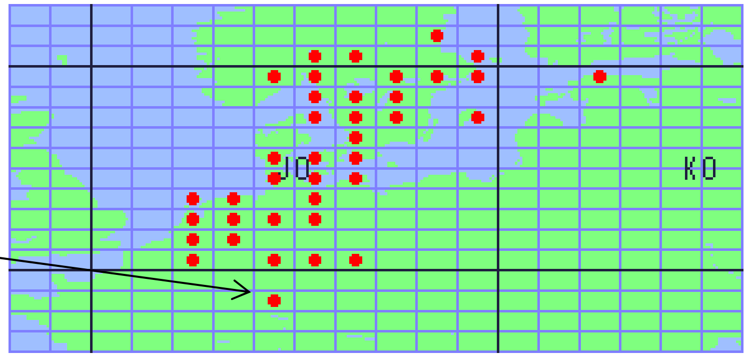
Squares worked from JO59IX

Status 2012



432 MHz
ODX: RW3PF
KO93CD 1837km

1296 MHz
ODX: DF9IC
JN48IW 1235km



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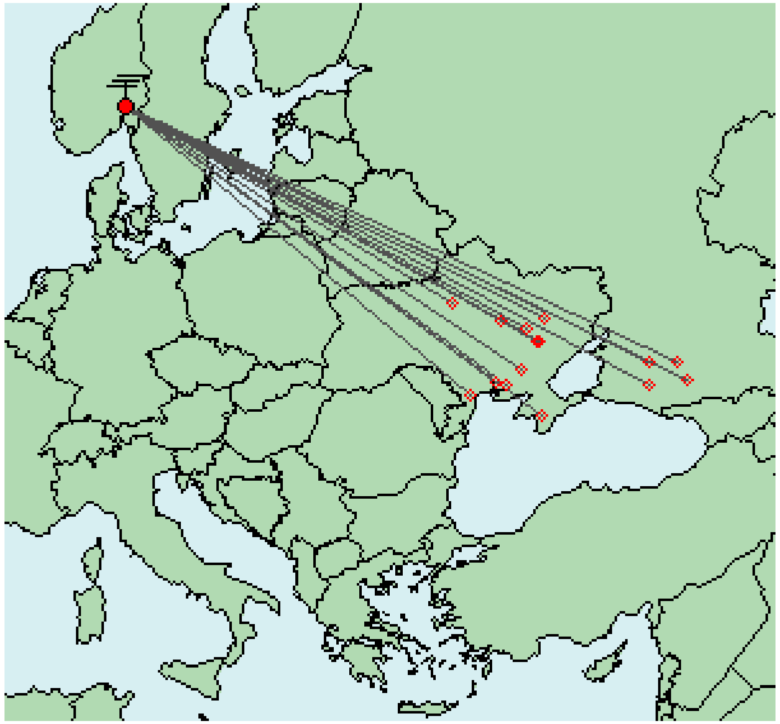
Do I still enjoy operating on higher bands after so many years?

- Yes – definitely
  - Perhaps becoming more selective
  - Focus on higher bands?
- Sometimes I catch a unique situation
  - Examples of Sporadic-E and Tropo

Sporadic-E during NAC

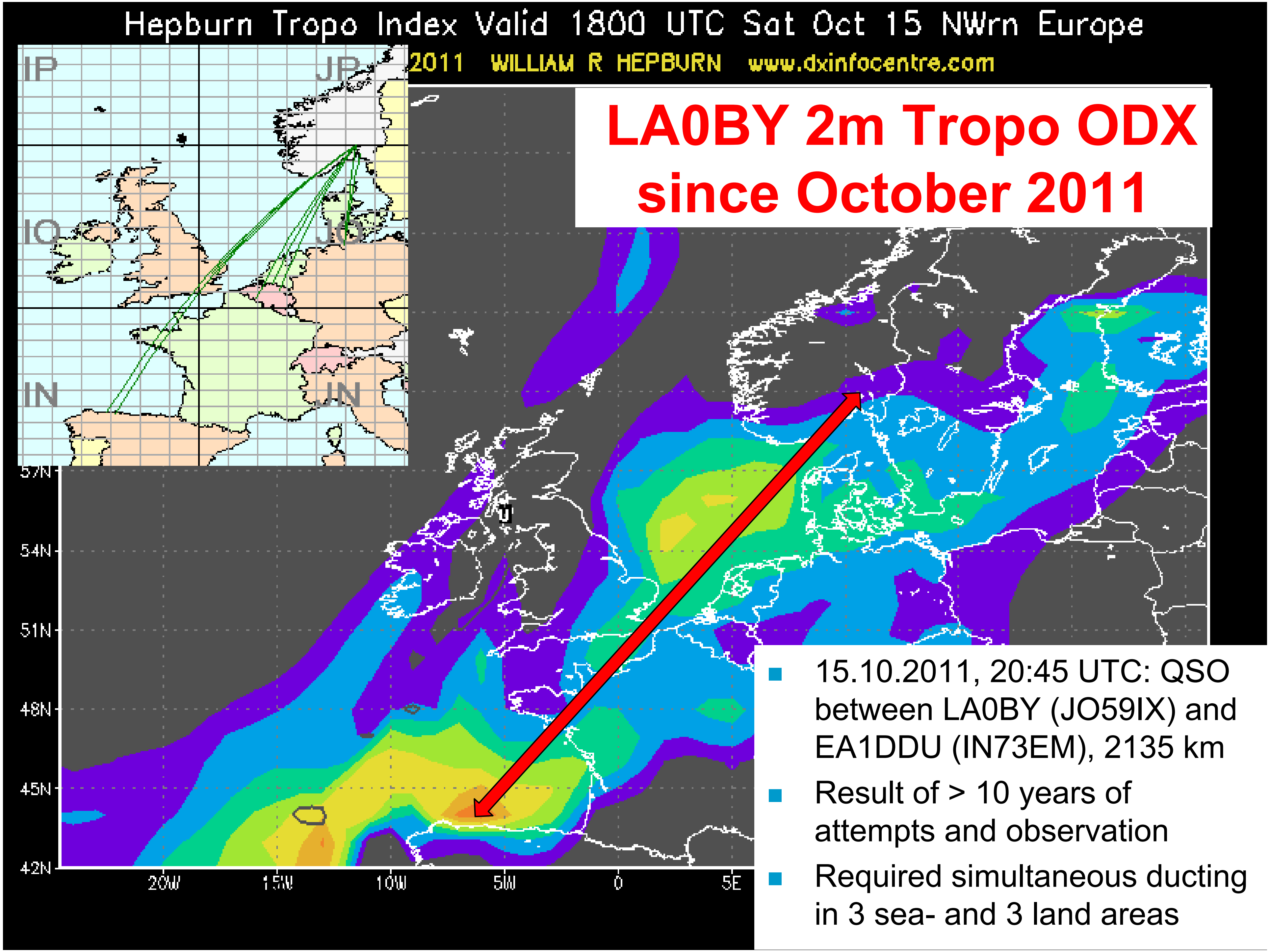


1.6.2010: LA0BY in JO59IX - 144 MHz

1736 UY2QQ KN77OT 55 55 2078km
1748 US5EII KN78JK 539 59 2005km
1802 UR4UW KO50LI 59 59 1661km
1806 UZ2HZ KN69RA 59 59 1892km
1815 UT3EW KN78IL 579 58 1997km
1818 RV6YY LN04AO 59 59 2589km
1823 RW6AH LN05GK 57 57 2542km
1824 UT7QF KN77MV 59 59 2063km
1828 UR6EC KN78XM 57 55 2055km
1832 **UA6EC** LN14AE 55 59 **2725km ODX**
1849 RA6HHT LN04WX 57 57 2648km
1909 UR5FFC KN56GQ 599 599 1964km
2032 US0GB KN67UA 579 579 2075km
2044 UY5HF KN66HP 55 59 2059km
2102 US8ZAL KN66AU 55 59 2014km
2105 UU2JJ KN75AA 54 54 2270km
2109 US0GB KN67UA 55 59 2075km

=> Won against LA2Z due to focus on Es

LA0BY 2m Tropo ODX since October 2011

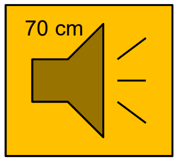


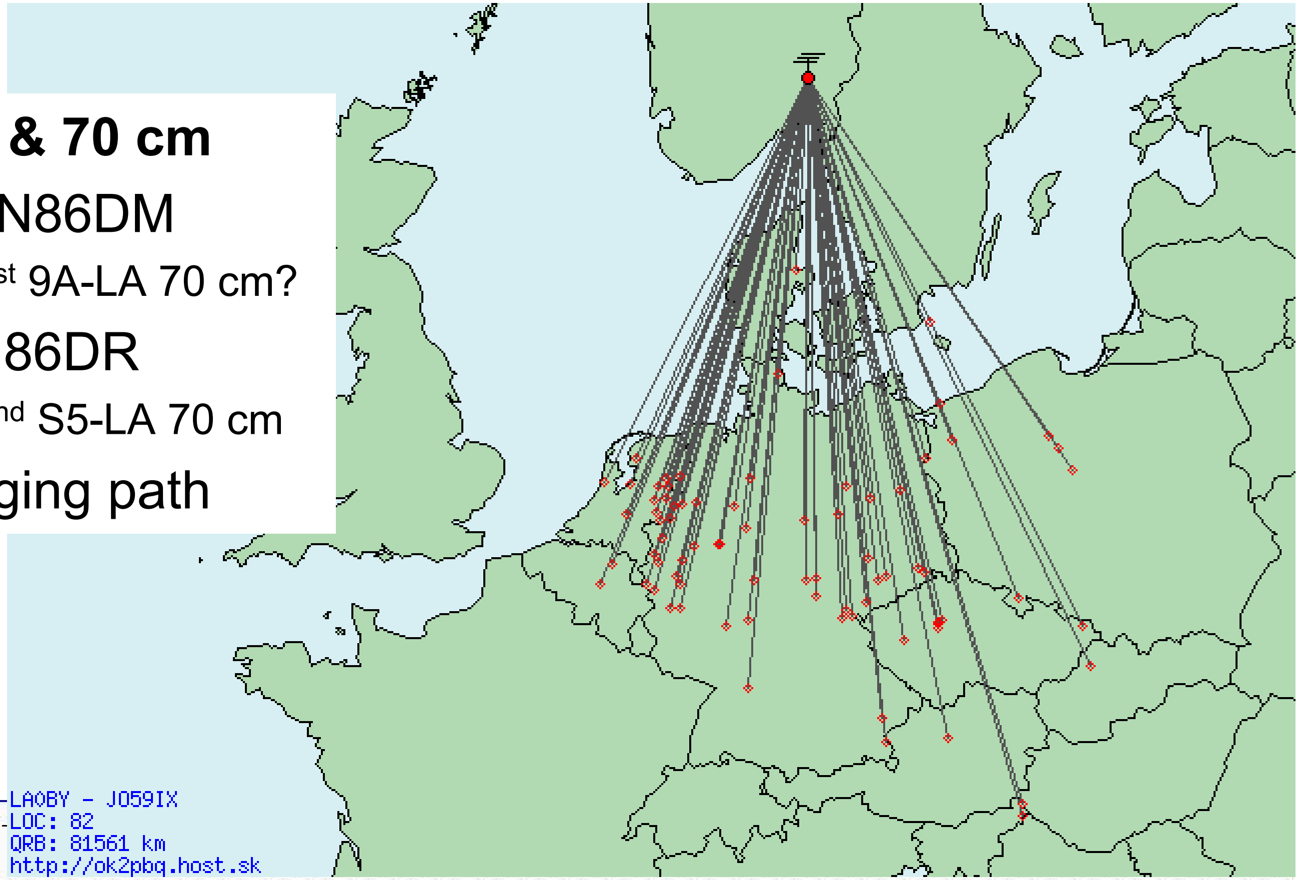
- 15.10.2011, 20:45 UTC: QSO between LA0BY (JO59IX) and EA1DDU (IN73EM), 2135 km
- Result of > 10 years of attempts and observation
- Required simultaneous ducting in 3 sea- and 3 land areas

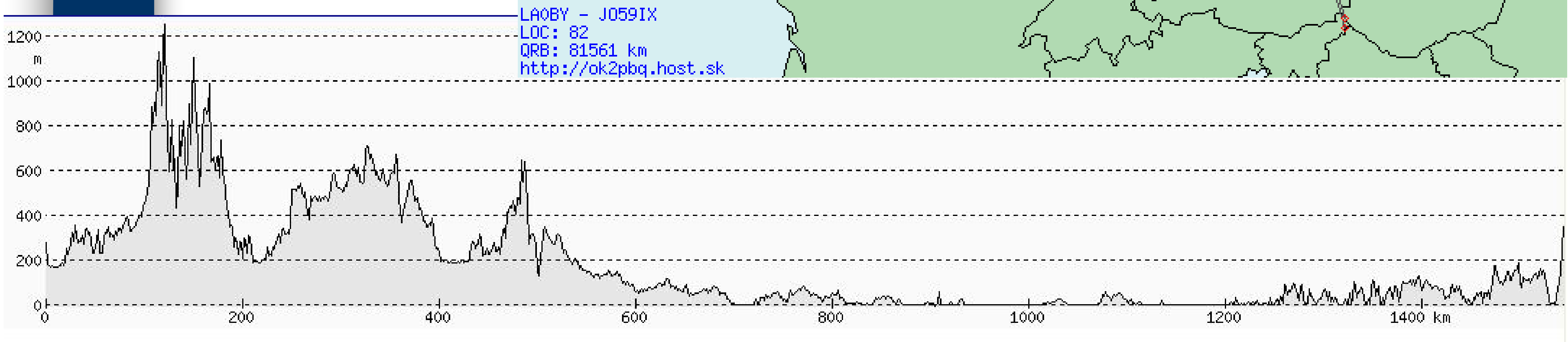
Late winter Tropo opening 2015

Highlights 2 m & 70 cm

- 9A1CAL in JN86DM
  - 1560 km, 1st 9A-LA 70 cm?
- S51ZO in JN86DR
  - 1518 km, 2nd S5-LA 70 cm
- Very challenging path





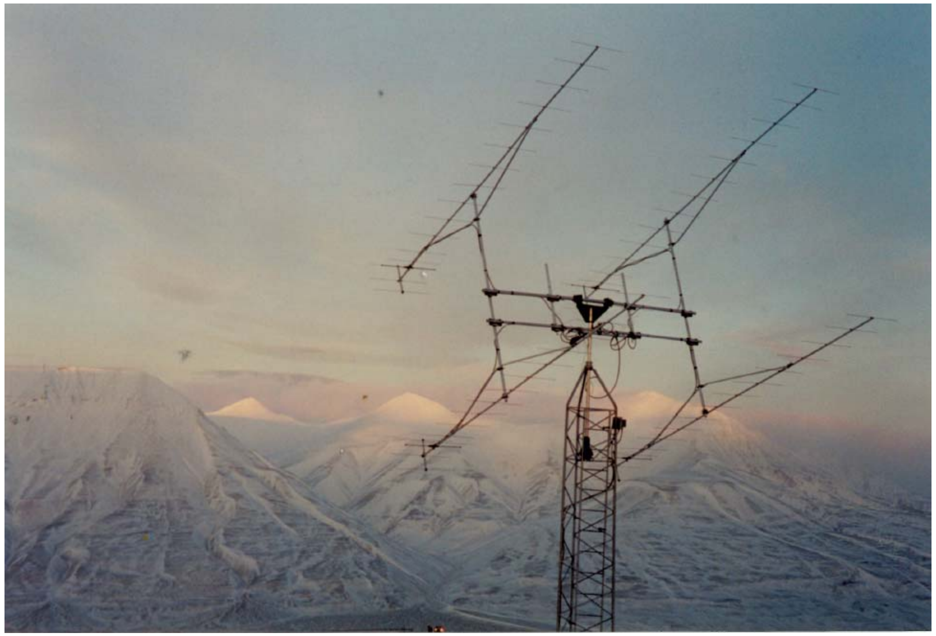


Not far enough? – Go EME!

Earth-Moon-Earth (EME) or Moonbounce

- Moon is used as reflector for radiowaves
- Requires very high EIRP and sensitive receiver => used to demand large antenna systems
- Digimodes have reduced equipment requirements

144 MHz EME from Svalbard:
JW0BY in JQ88AD



EME

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LA8YB the EME Monster

- 32 x 17-ele-yagi (10 m boom)
- Build by a dedicated man

LA0BY 2015