Assessing the accuracy of the new Chisham *et al.* SuperDARN virtual height model in mapping ionospheric backscatter

T. K. Yeoman[1], G. Chisham[2], L. J. Baddeley[3], R. S. Dhillon[1], T. J. T. Karhunen[1], T. R.Robinson[1], A. Senior[4], and D. M. Wright[1]

[1]Dept. of Physics and Astronomy, University of Leicester, UK
[2]British Antarctic Survey, Cambridge, CB3 0ET, UK
[3]EISCAT Scientific Association, Kiruna, Sweden
[4]Department of Communication Systems, Lancaster University, UK

SuperDARN Workshop, 2008

Mapping ionospheric backscatter measured by the SuperDARN HF radars – Part 1: A new empirical virtual height model

G. Chisham, T. K. Yeoman, and G. J. Sofko, Ann. Geophys., 26, 823–841, 2008

Mapping ionospheric backscatter measured by the SuperDARN HF radars – Part 2: Assessing SuperDARN virtual height models

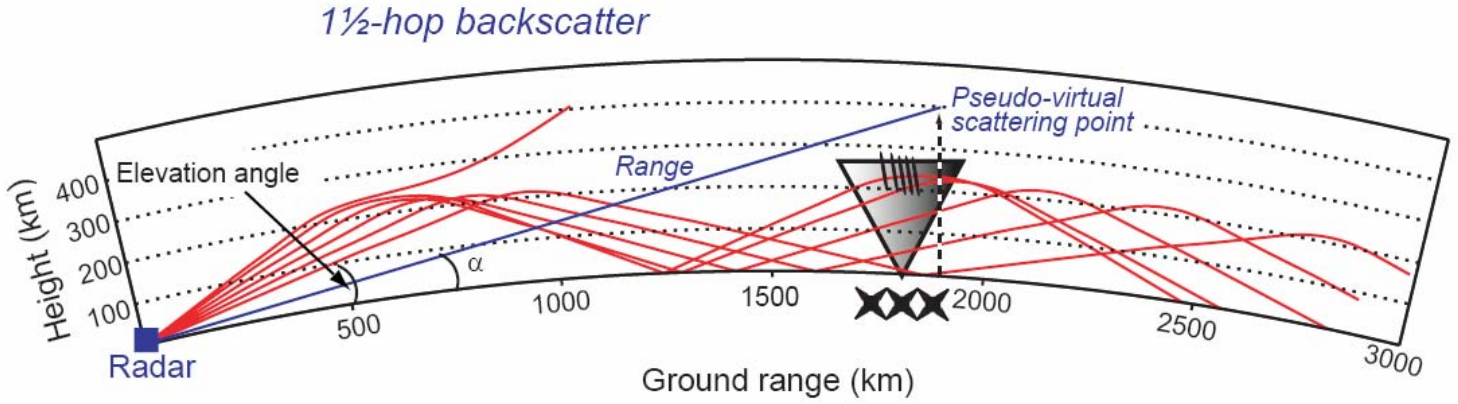
T. K. Yeoman, G. Chisham, L. J. Baddeley, R. S. Dhillon, T. J. T. Karhunen, T. R. Robinson, A. Senior, and D. M. Wright , Ann. Geophys., 26, 843–852, 2008

Both just out!

University of Leicester

Mapping ionospheric backscatter measured by the SuperDARN HF radars – Part 1: A new empirical virtual height model

G … 23-
8 …



A … N
H …
n …

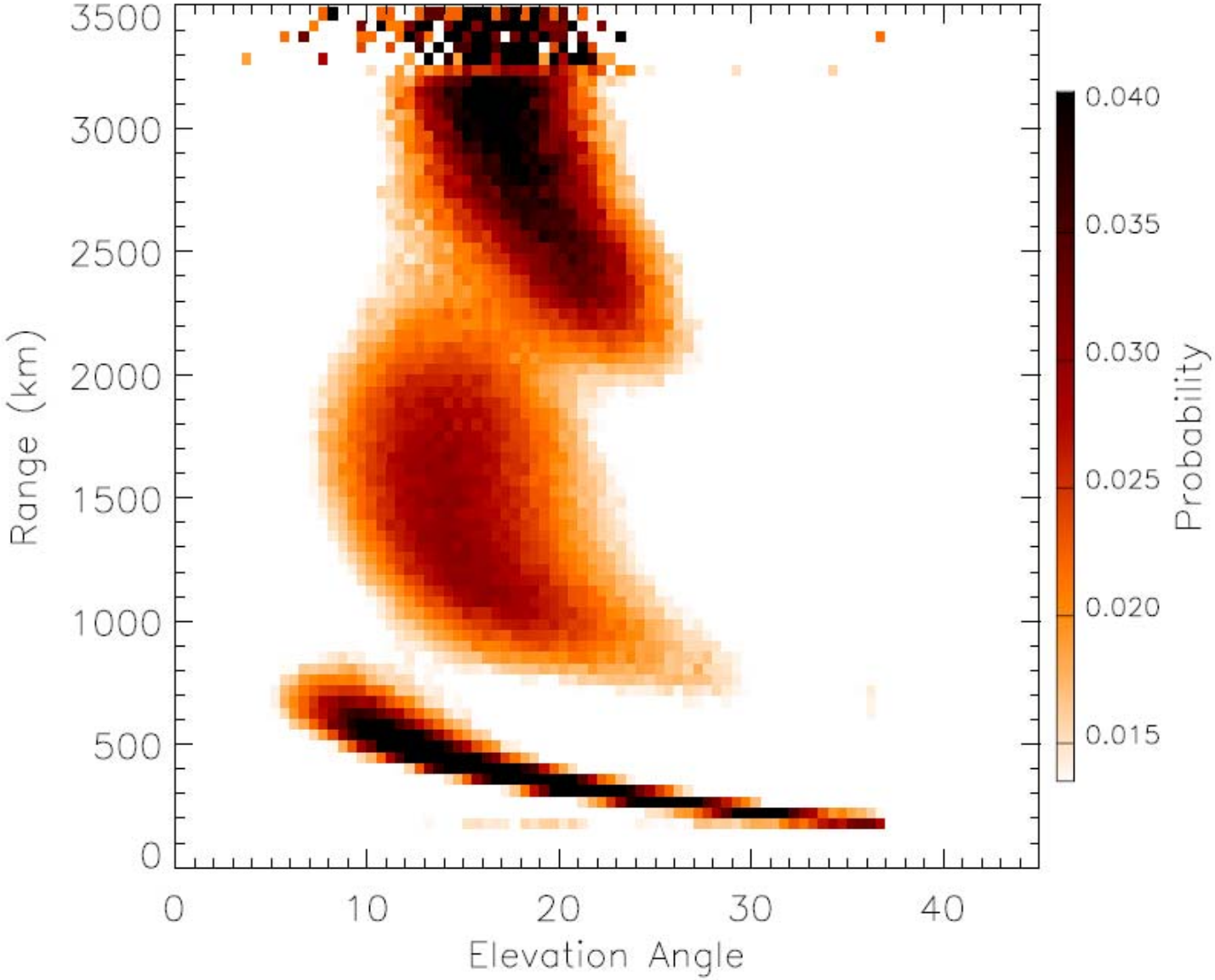
T. K. … T.
Karh … n.
Geop …

Both …

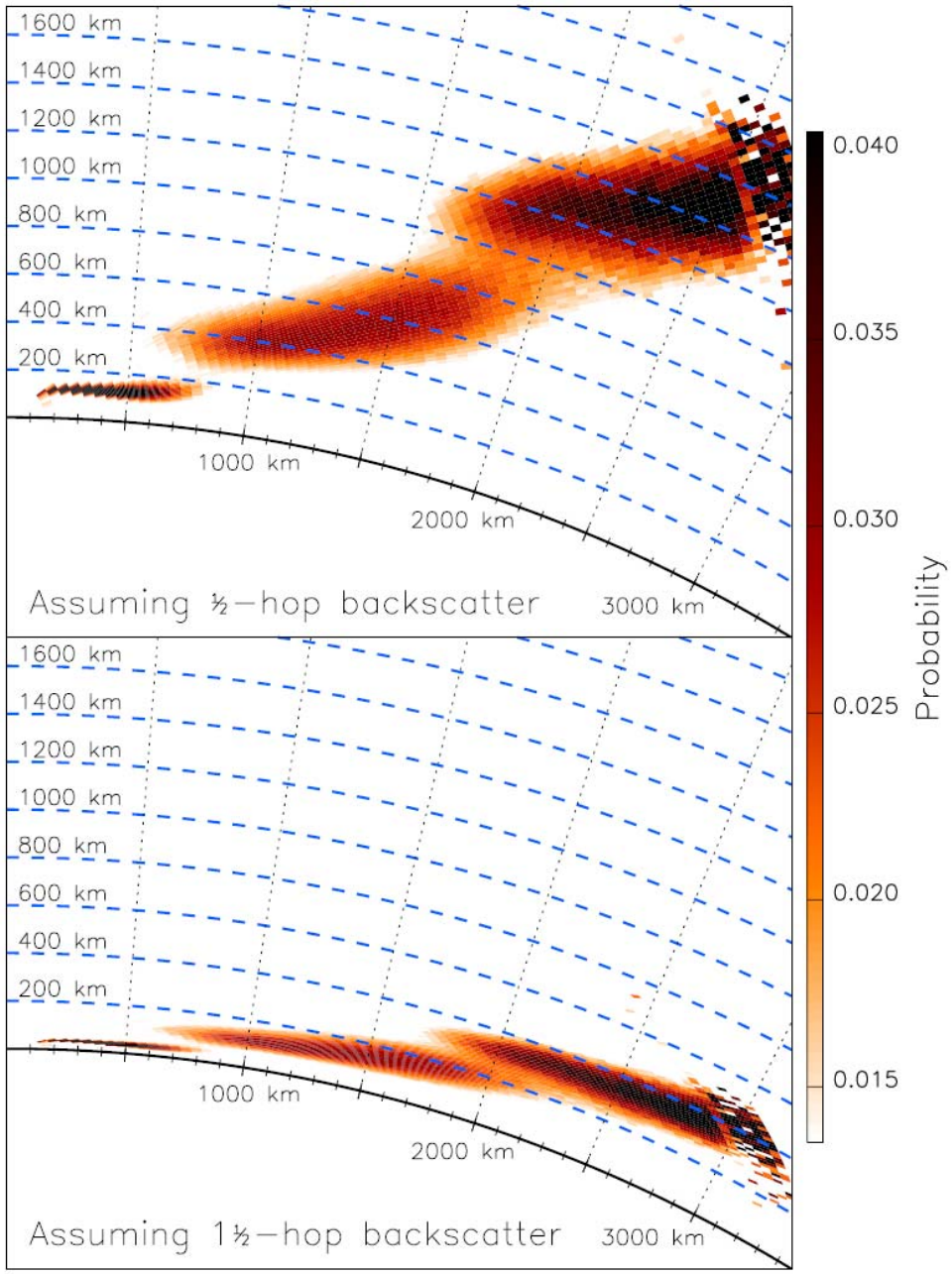
The current SuperDARN rangefinding algorithm

$$h_v = \begin{cases} \frac{115r}{150} & \text{for } 0 < r < 150 \text{ km} \\ 115 & \text{for } 150 \leq r \leq 600 \text{ km} \\ \frac{r-600}{200}(h_i - 115) + 115 & \text{for } 600 < r < 800 \text{ km} \\ h_i & \text{for } r \geq 800 \text{ km} \end{cases}$$

½-hop E region, ½-hop F region and 1½-hop F region scatter regions

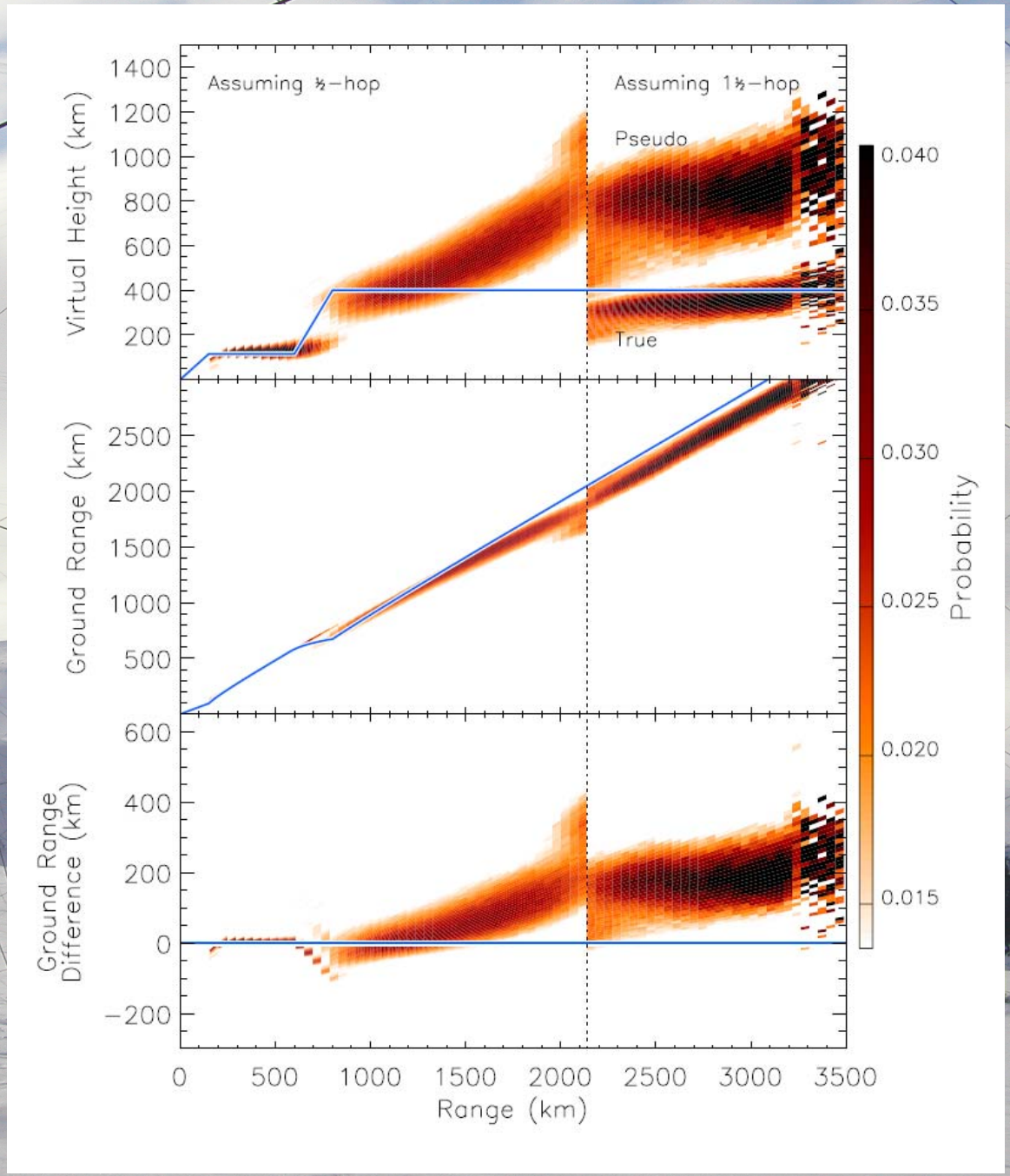


Convert to virtual height vs range assuming $\frac{1}{2}$ -hop scatter and $1\frac{1}{2}$ -hop scatter



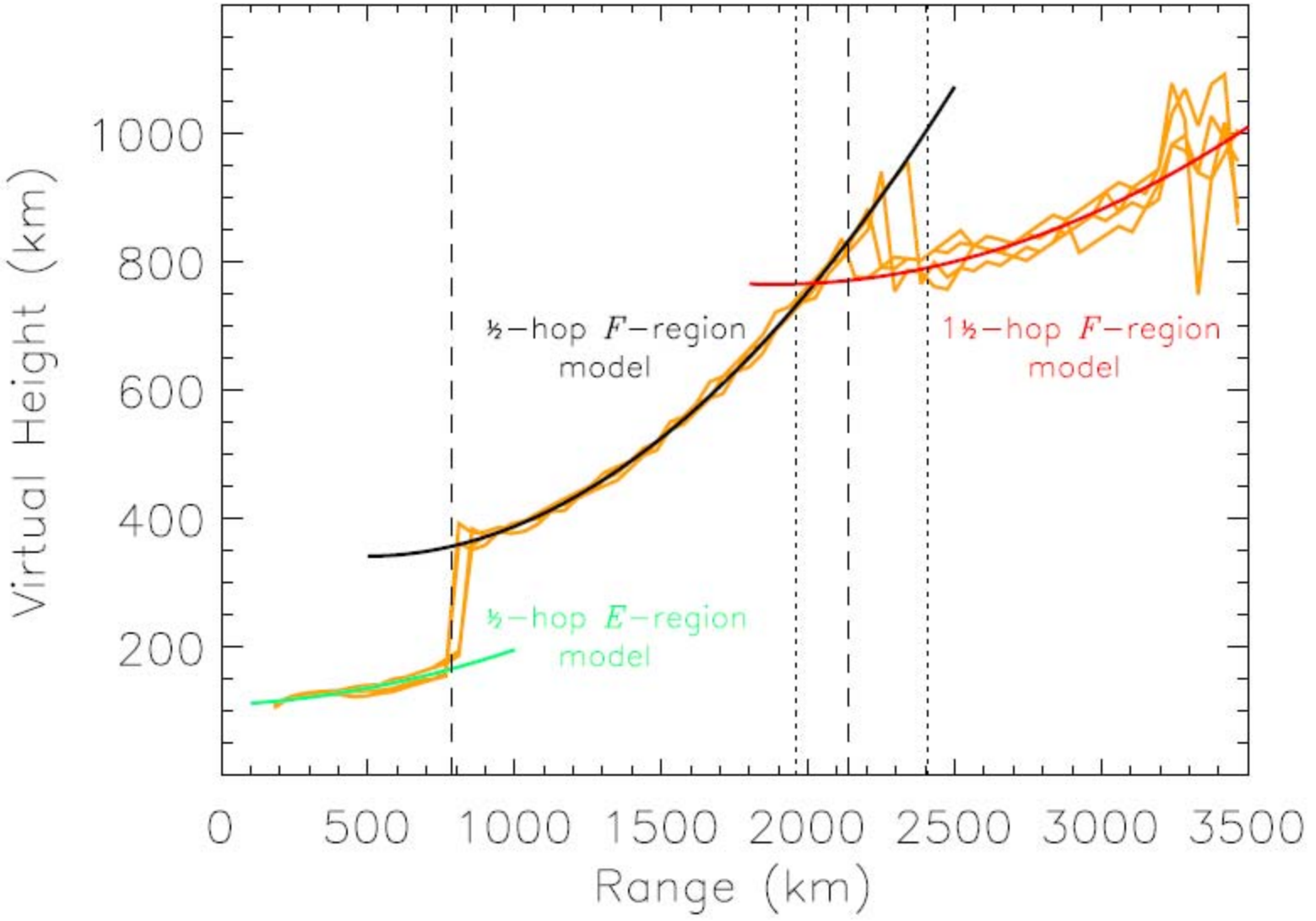
University of Leicester

Compare these virtual heights with those in the standard rangefinding algorithm



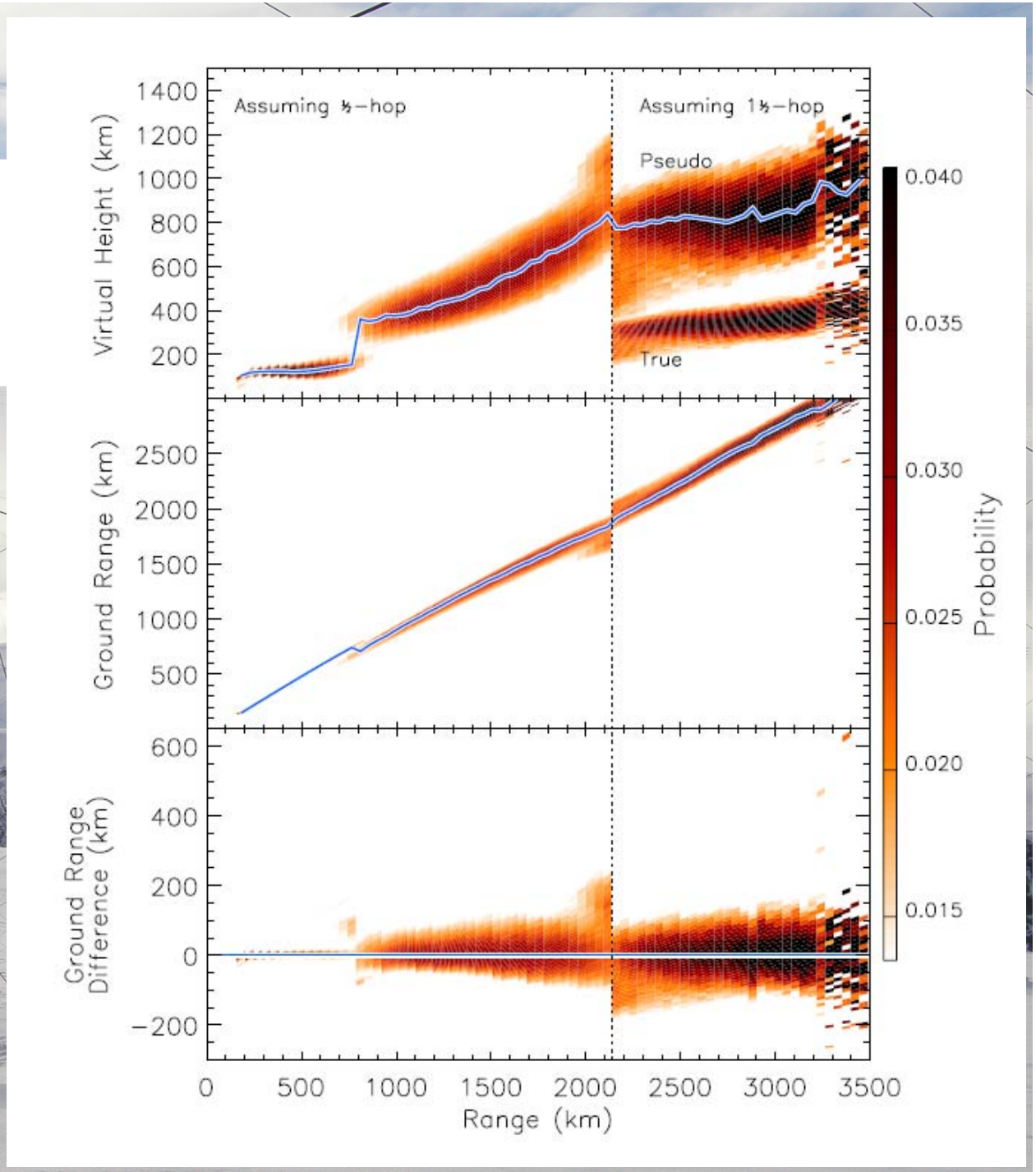
University of Leicester

Define a new virtual height model based on these measurements

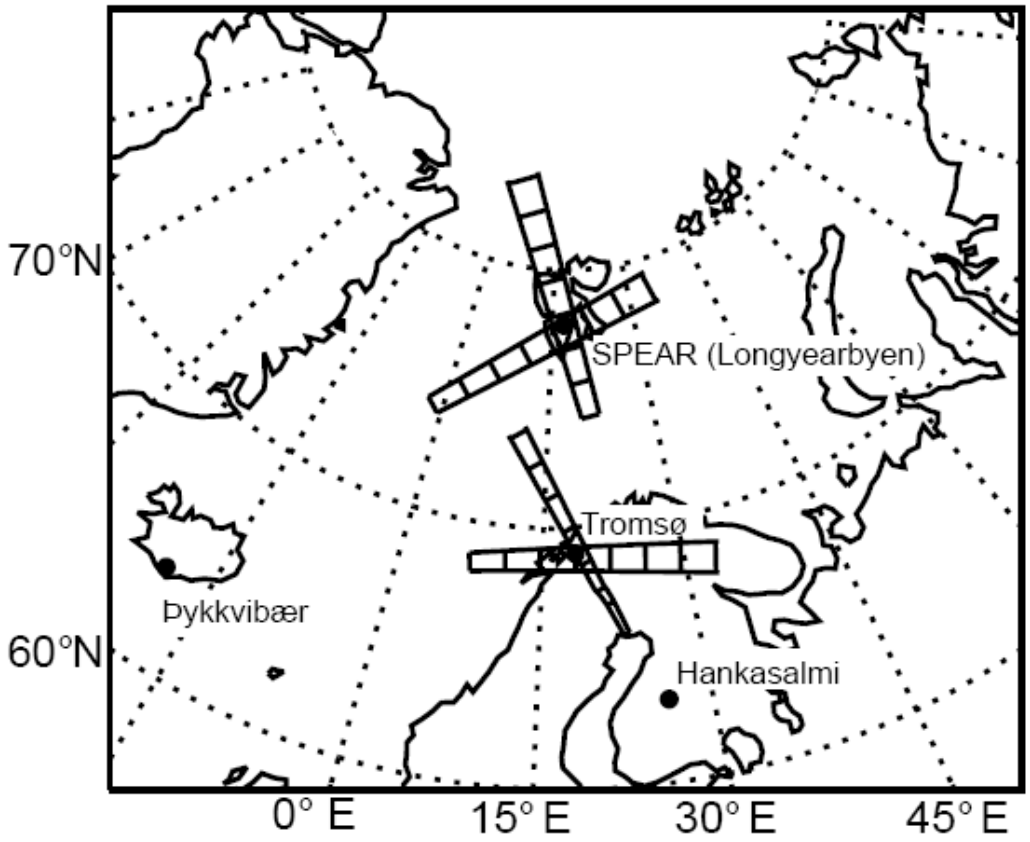


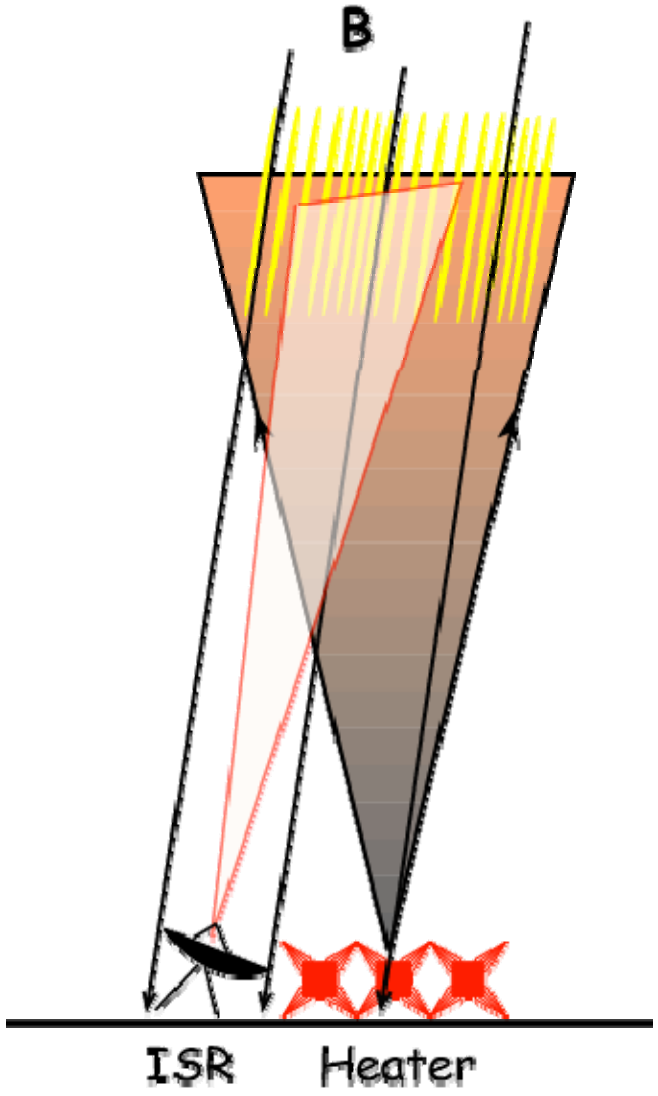
That looks better…

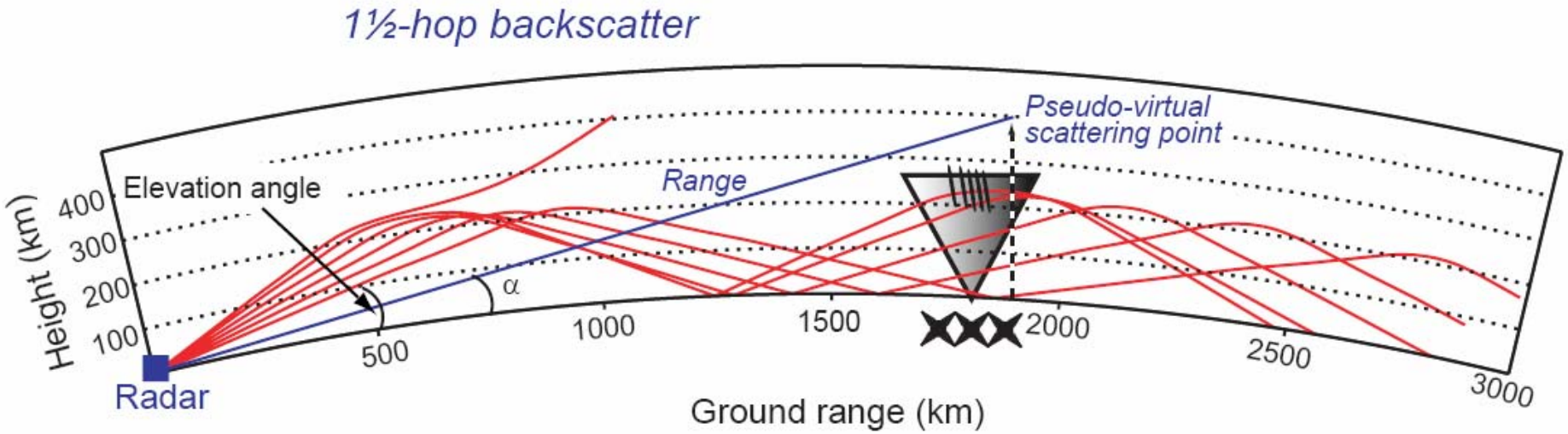
But does it actually work?

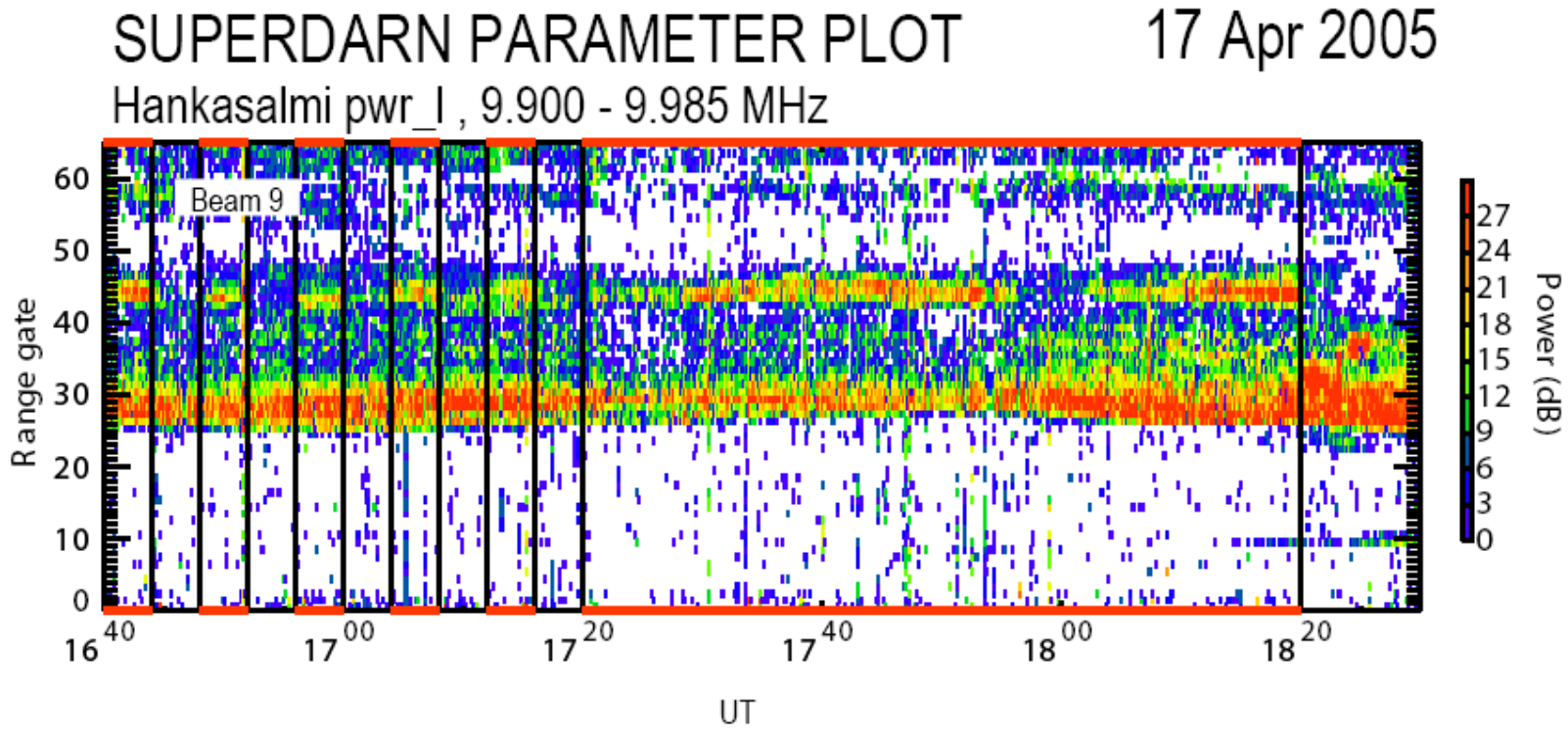


University of Leicester


70°N
60°N
0° E
15° E
30° E
45° E
SPEAR (Longyearbyen)
Tromsø
Þykkvibær
Hankasalmi


B
ISR
Heater


1½-hop backscatter
Pseudo-virtual
scattering point
Range
Elevation angle
α
Height (km)
400
300
200
100
500
1000
1500
2000
2500
3000
Radar
Ground range (km)


SUPERDARN PARAMETER PLOT
17 Apr 2005
Hankasalmi pwr_l , 9.900 - 9.985 MHz
Beam 9
Range gate
60
50
40
30
20
10
0
16 40
17 00
17 20
17 40
18 00
18 20
UT
Power (dB)
27
24
21
18
15
12
9
6
3
0

a) Fixed 400 km pseudo-virtual height

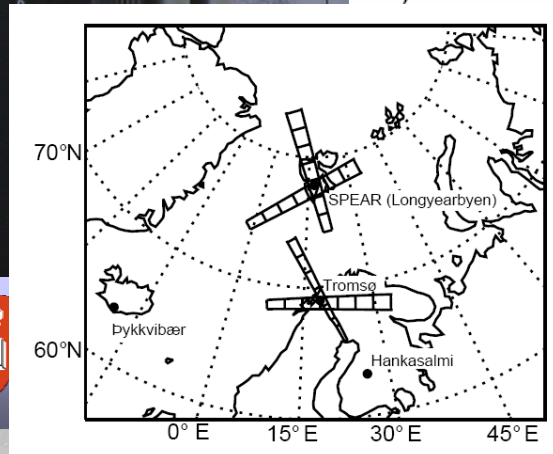
(*i*) Han-Tro 981015 (*ii*) Þyk-Tro 981015 (*iii*) Þyk-Tro 041203 (*iv*) Han-SPEAR 05 (*v*) Þyk-SPEAR 05

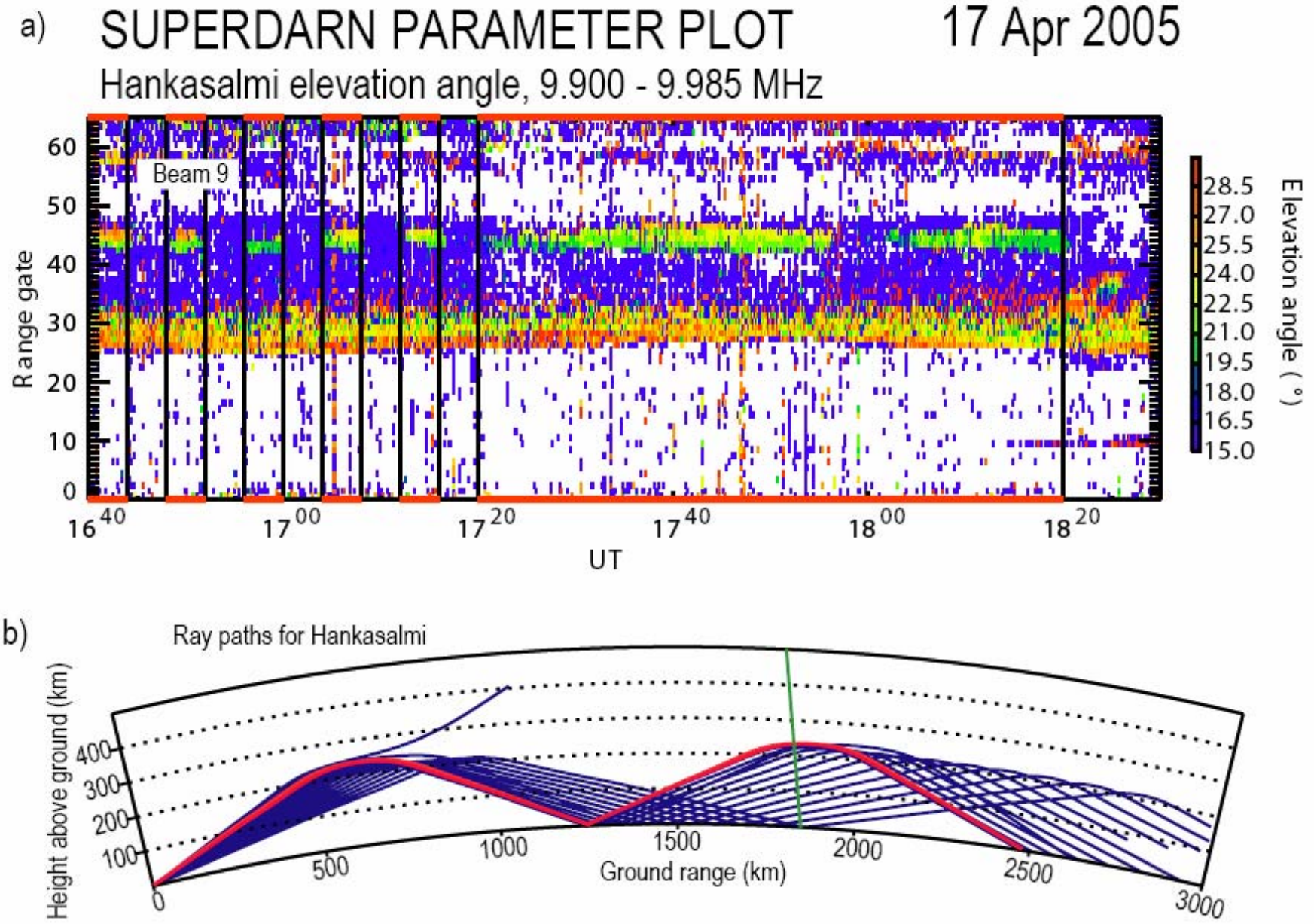
b) ½-hop pseudo-virtual height model

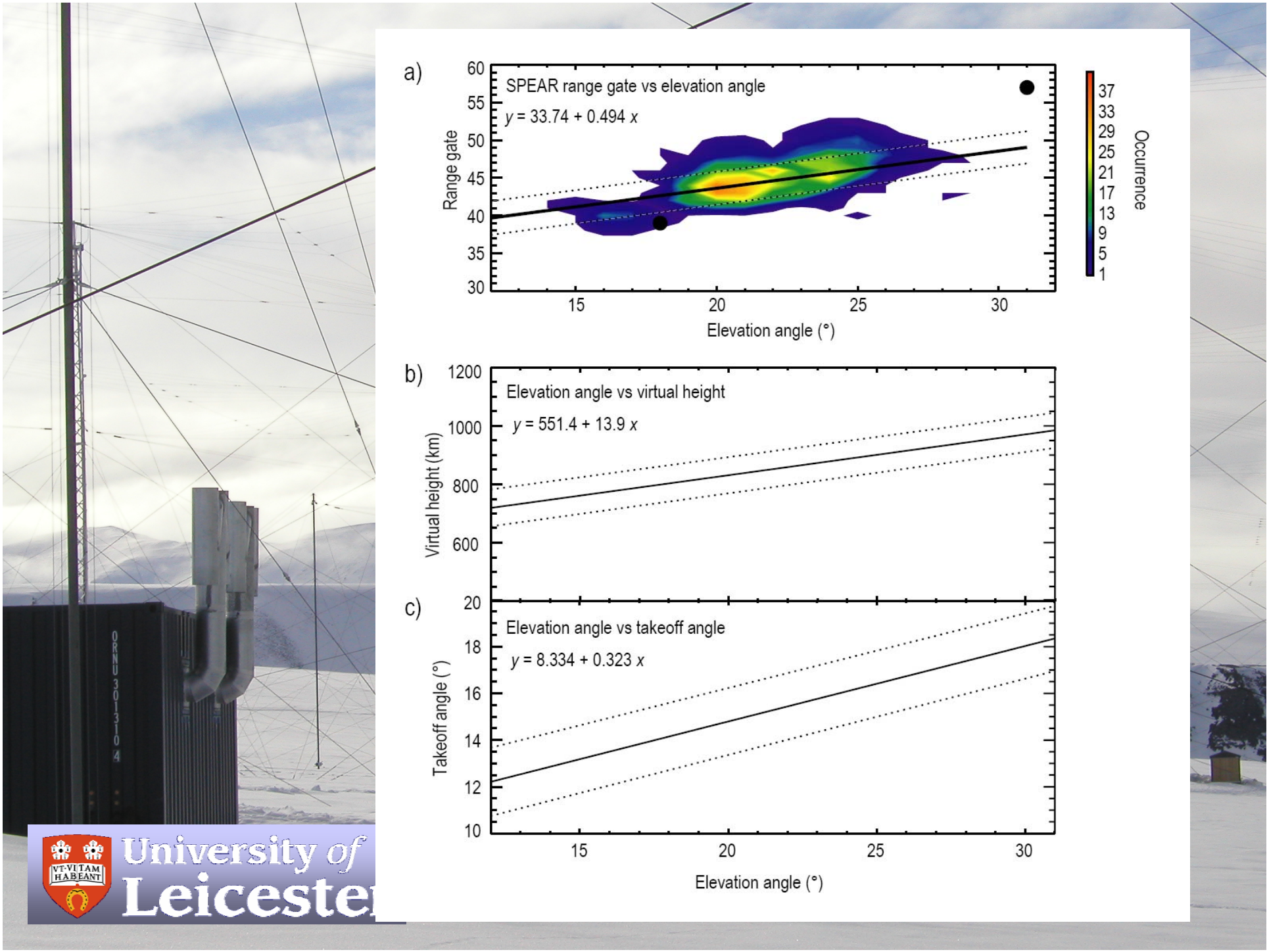
(*i*) Han-Tro 981015 (*ii*) Þyk-Tro 981015 (*iii*) Þyk-Tro 041203 (*iv*) Han-SPEAR 05 (*v*) Þyk-SPEAR 05

c) 1½-hop pseudo-virtual height model

(*ii*) Þyk-Tro 981015 (*iii*) Þyk-Tro 041203 (*iv*) Han-SPEAR 05 (*v*) Þyk-SPEAR 05

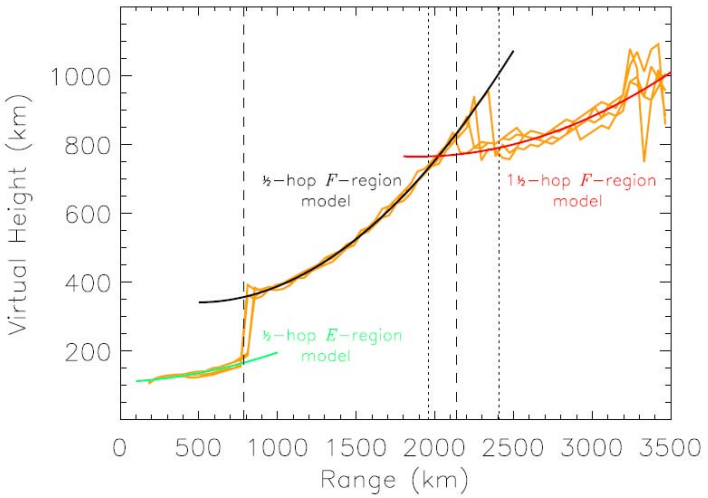



a)
SUPERDARN PARAMETER PLOT
17 Apr 2005
Hankasalmi elevation angle, 9.900 - 9.985 MHz
Beam 9
Range gate
60
50
40
30
20
10
0
16 40
17 00
17 20
17 40
18 00
18 20
UT
28.5
27.0
25.5
24.0
22.5
21.0
19.5
18.0
16.5
15.0
Elevation angle (°)
b)
Ray paths for Hankasalmi
Height above ground (km)
400
300
200
100
0
500
1000
1500
2000
2500
3000
Ground range (km)



University of Leicester


$$h_v = \begin{cases} \frac{115r}{150} & \text{for } 0 < r < 150 \text{ km} \\ 115 & \text{for } 150 \leq r \leq 600 \text{ km} \\ \frac{r-600}{200}(h_i - 115) + 115 & \text{for } 600 < r < 800 \text{ km} \\ h_i & \text{for } r \geq 800 \text{ km} \end{cases}$$
University of Leicester



$$h^*(r) = A + Br + Cr^2$$

Backscatter Type	A	B	C
$\frac{1}{2}$-hop E region	108.974	0.0191271	6.68283×10^{-5}
$\frac{1}{2}$-hop F region	384.416	-0.178640	1.81405×10^{-4}
$1\frac{1}{2}$-hop F region	1098.28	-0.354557	9.39961×10^{-5}

This new algorithm is well worth adopting in the standard analysis of SuperDARN data…

…and it is worth using the elevation angle data to correct the range when we've got it

Leicester