Benefits of Dual Polarization in severe storms

CONTENTS

Case Study

- At C-Band attenuation is a problem in heavy rain – More so at X-band
- We will look at London 20th July 2007 case which caused widespread flooding
- Thanks to Rob Thompson at Reading University for plots

Background characteristics of microwave weather radars

Higher frequency: more severe Attenuation during critical events

From Delrieu et al, 2000:

Quantification of Path-Integrated Attenuation for X-band and C-band Weather Radar Systems Operating in the Mediterranean Heavy Rainfall

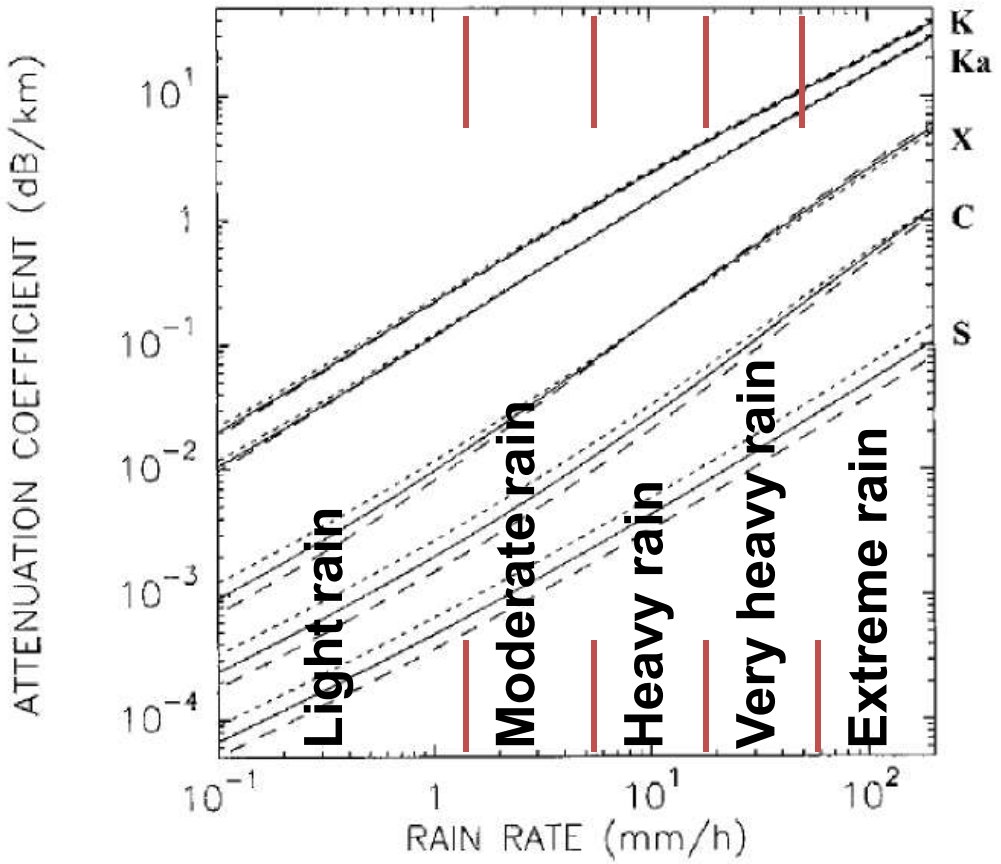
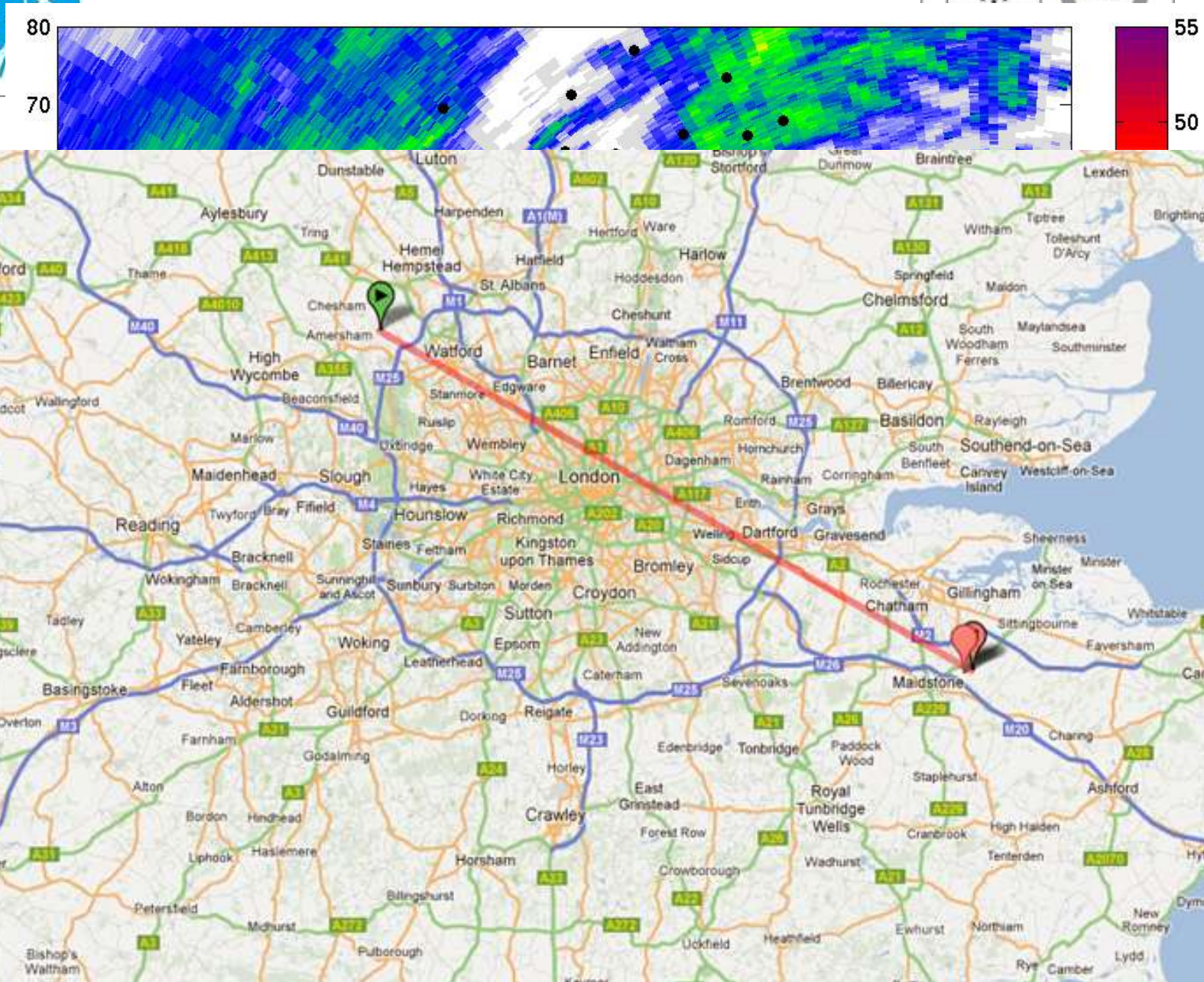
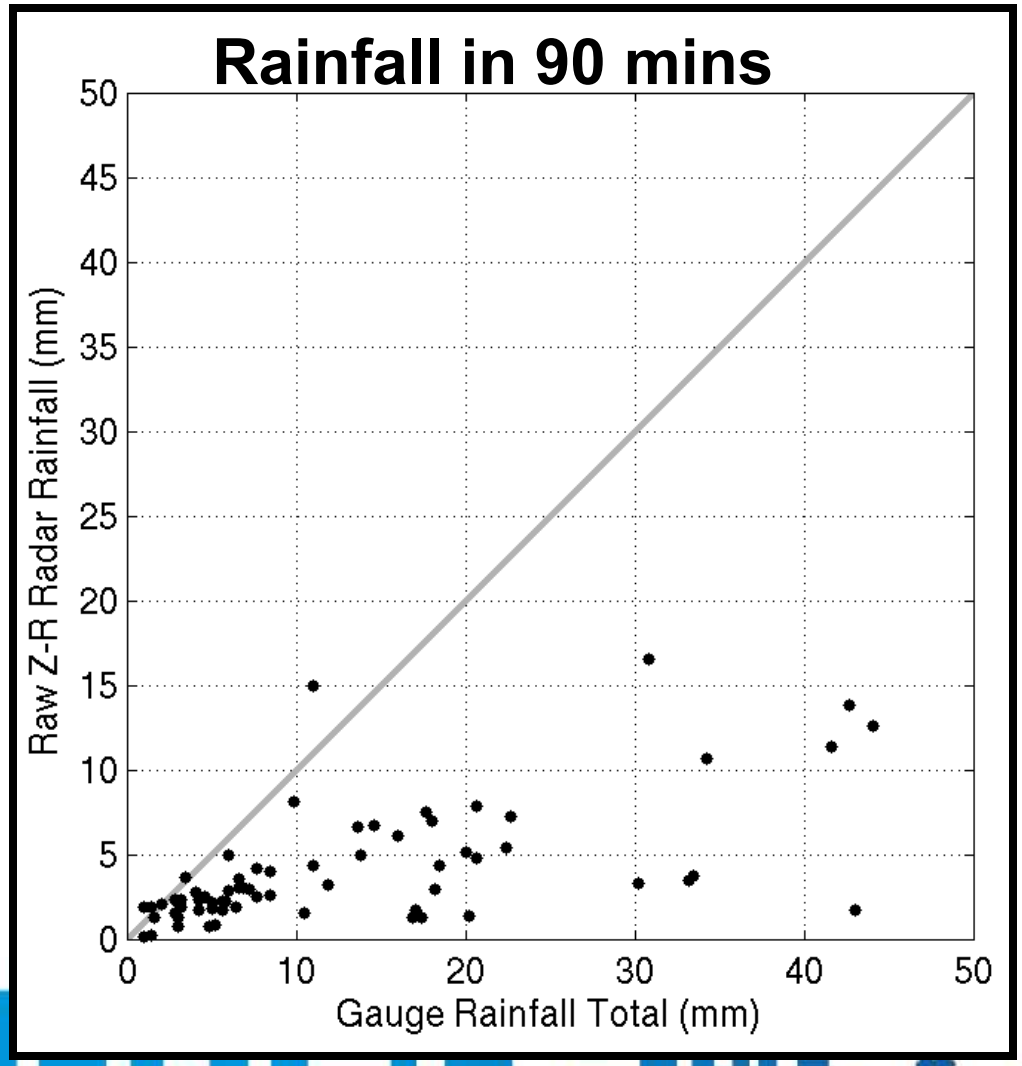


FIG. 3. Some examples of k–R relationships established using Mie theory (spherical rain drops) for the K- (0.86 cm), Ka- (1.15 cm), X- (3.2 cm), C- (5.6 cm), and S-band (10 cm) wavelengths and the Cévennes DSD model (see Table 1) for raindrop temperatures T = 0°C (dotted line), T = 10°C (continuous line), and T = 20°C (dashed line).

Z from Thurnham (Dual Pol.) radar at 1043.

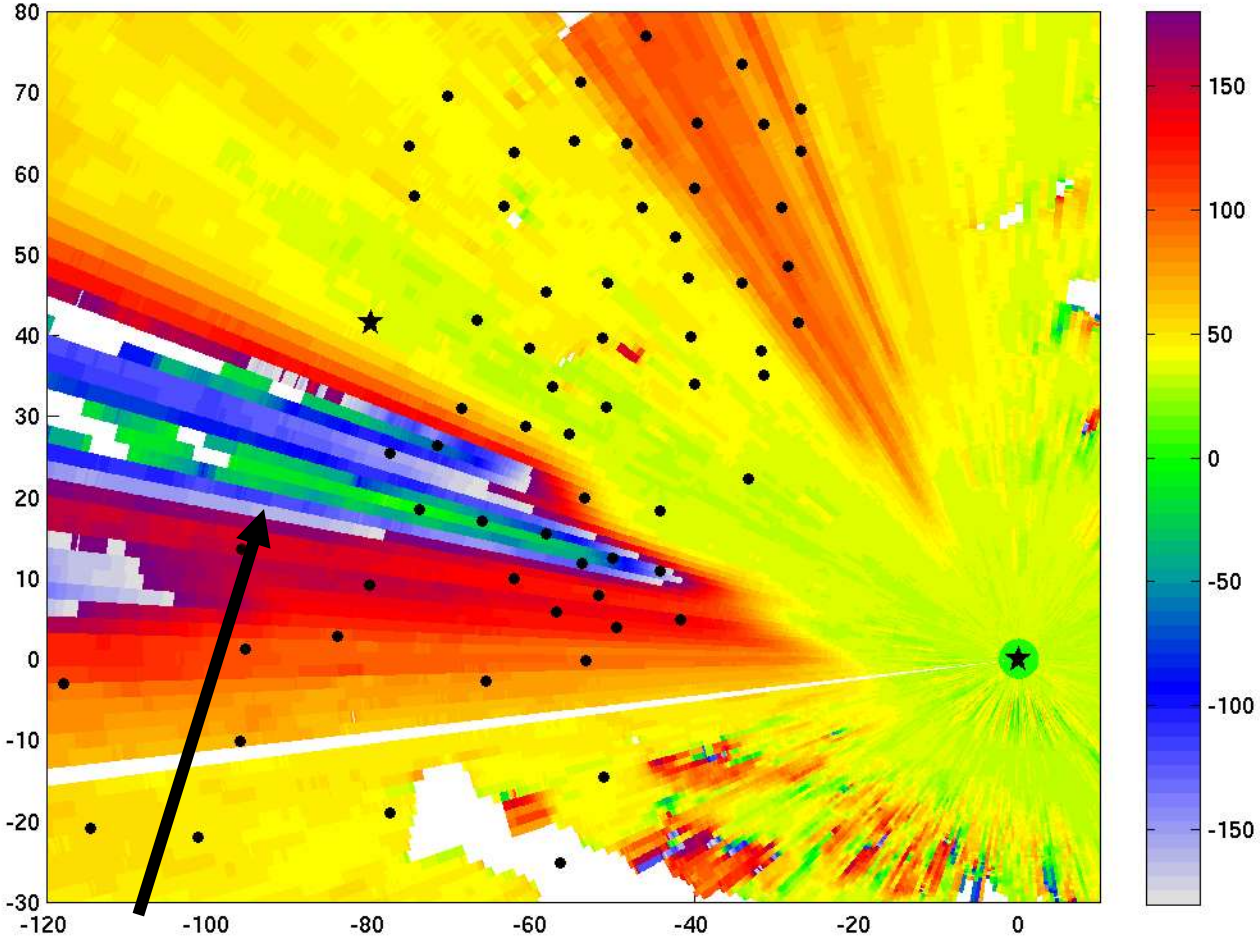


Gauge vs. Radar



- Uses $Z=200R^{1.6}$
- Almost all gauges were under estimated
  - Rain >10mm/hr mean 30% of gauge
- We will look at why we have this problem
- Slow moving (~23km/hr) so effects of winds and interpolation are small

Thurnham ϕ_{DP} at 1043

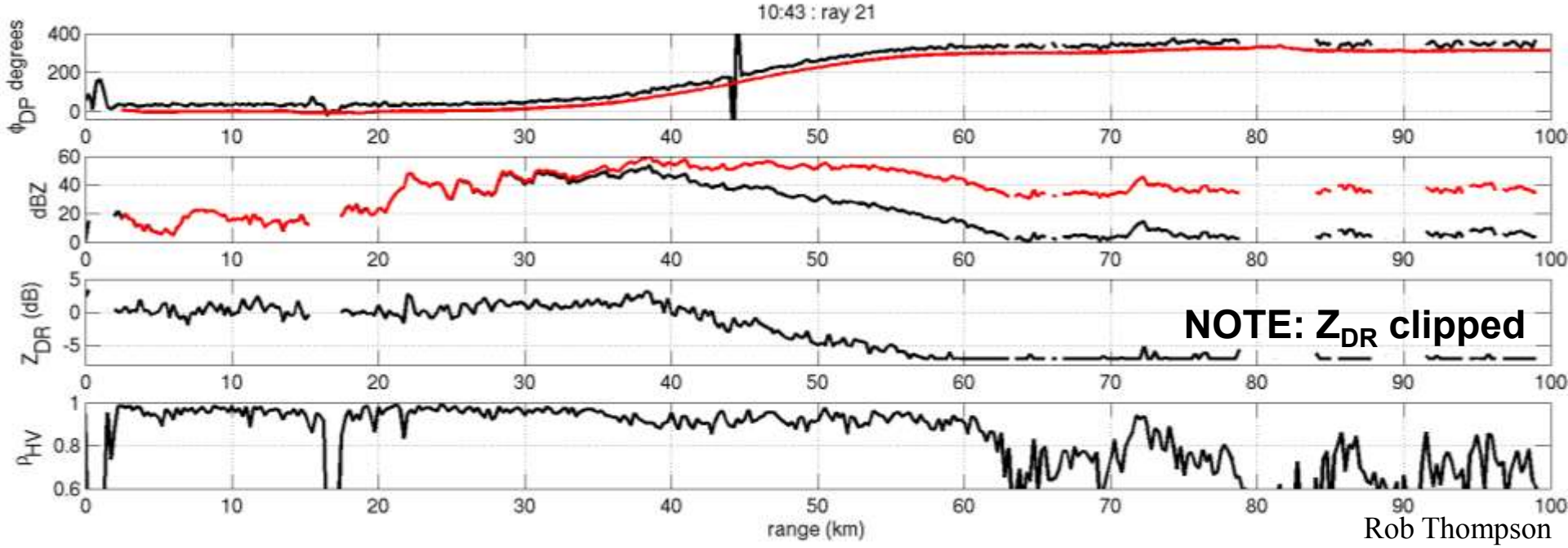


300 degs phase shift: 30dB attenuation?

1dB per 10 degs for gamma function with $\mu = 5$

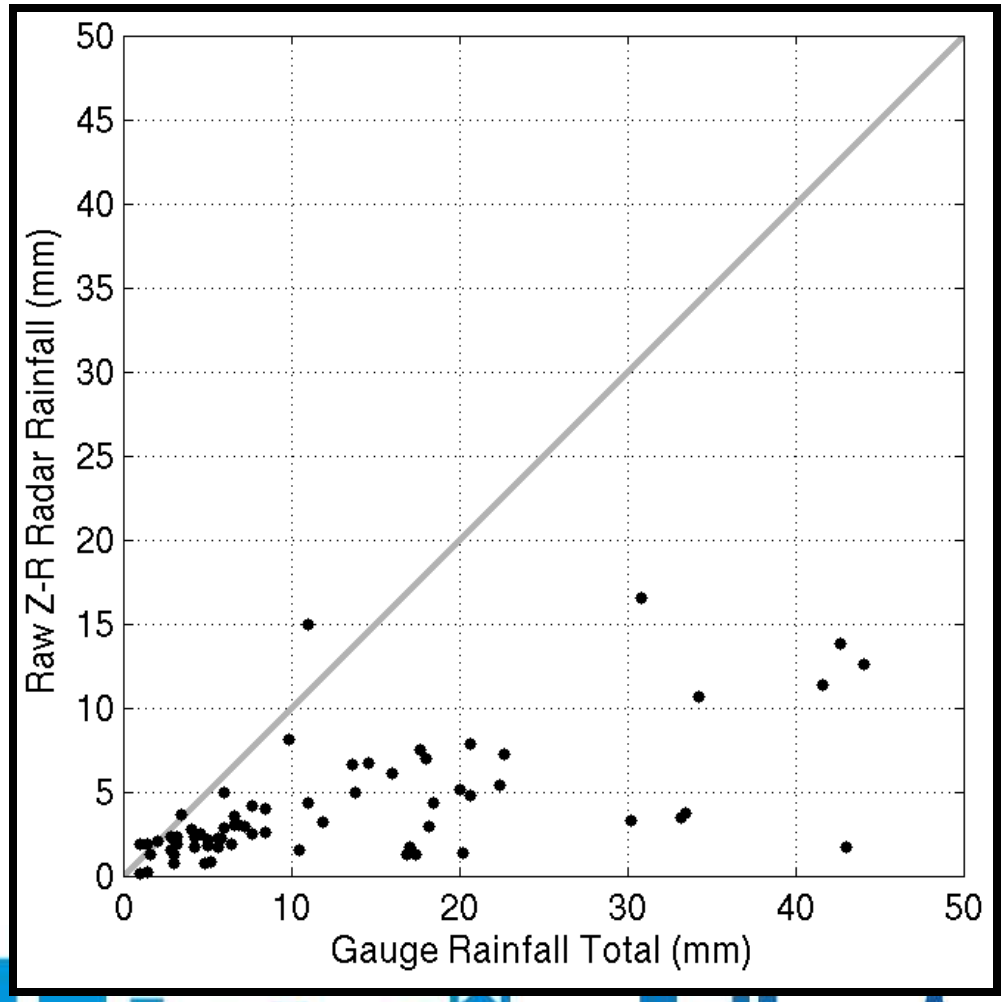
Attenuation Correction with Φ_{DP}

- Attenuation increases with Φ_{DP} so that $\Delta Z_H = \alpha \Phi_{DP}$
- vary α based on drop spectra, shapes and temperature.
- These values of α are generally around 0.1dB/^{o} in heavy rain
  - So must add 1dBZ for every 10^o of differential phase
  - Have Φ_{DP}=300^o ~ 30dB ± **?dB** of attenuation



Rob Thompson

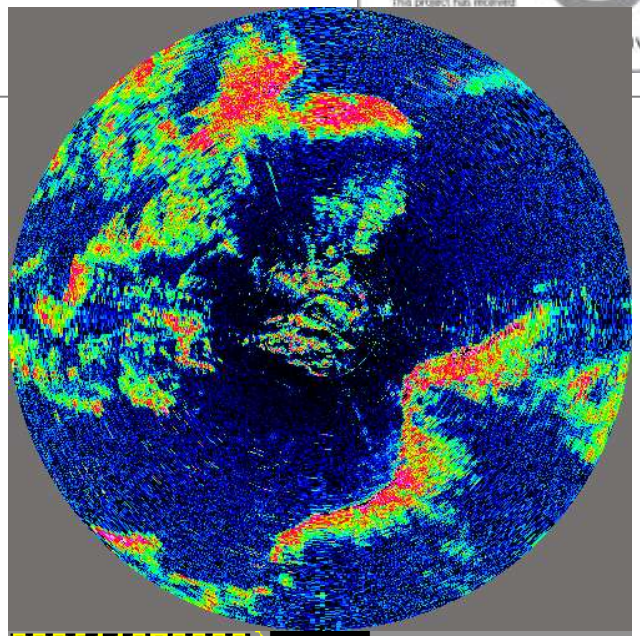
Gauge vs Att. Corrected Radar

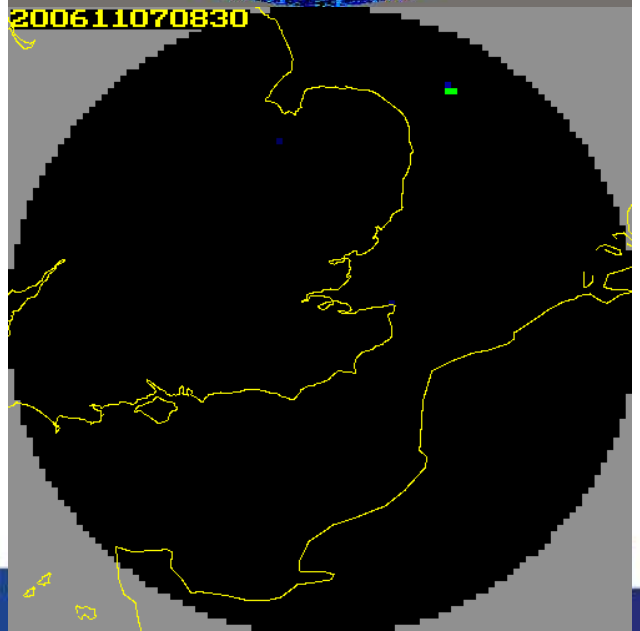


- Radar data corrected for attenuation using 10°/dB
- Attenuation correction clearly has massively improved the situation
  - Rain >10mm/hr
  - inside 80km
    - **98%**
- Still some big outliers
  - Vertical Structure related?
  - Clutter Related?

Spurious echo identification

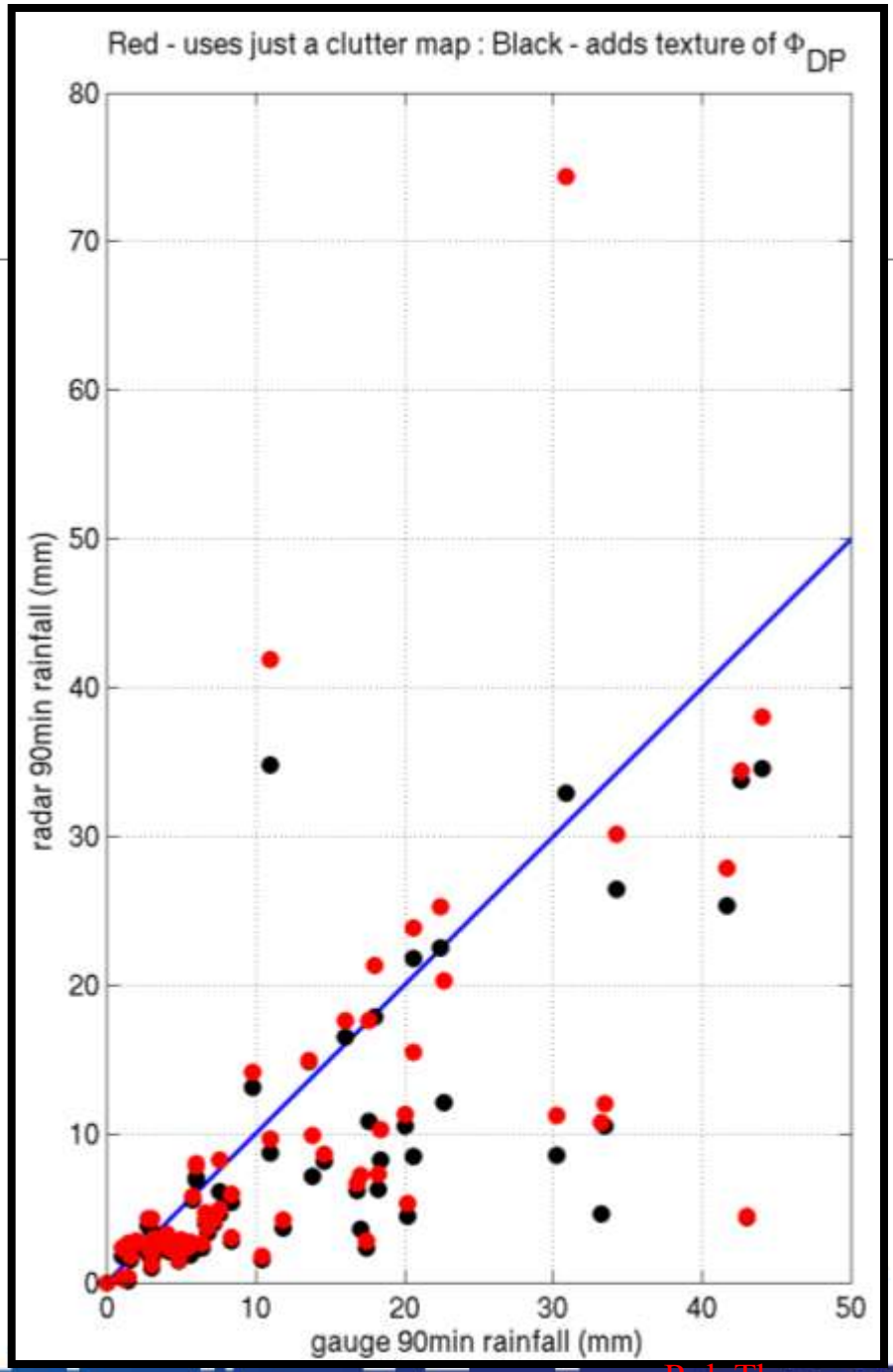
- Spurious echoes can be from ground, vegetation, buildings, planes, sea, boats, insects/birds…etc.
- Some are more easily identifiable than others.
- Dual polarisation can greatly help in the identification of spurious echoes.





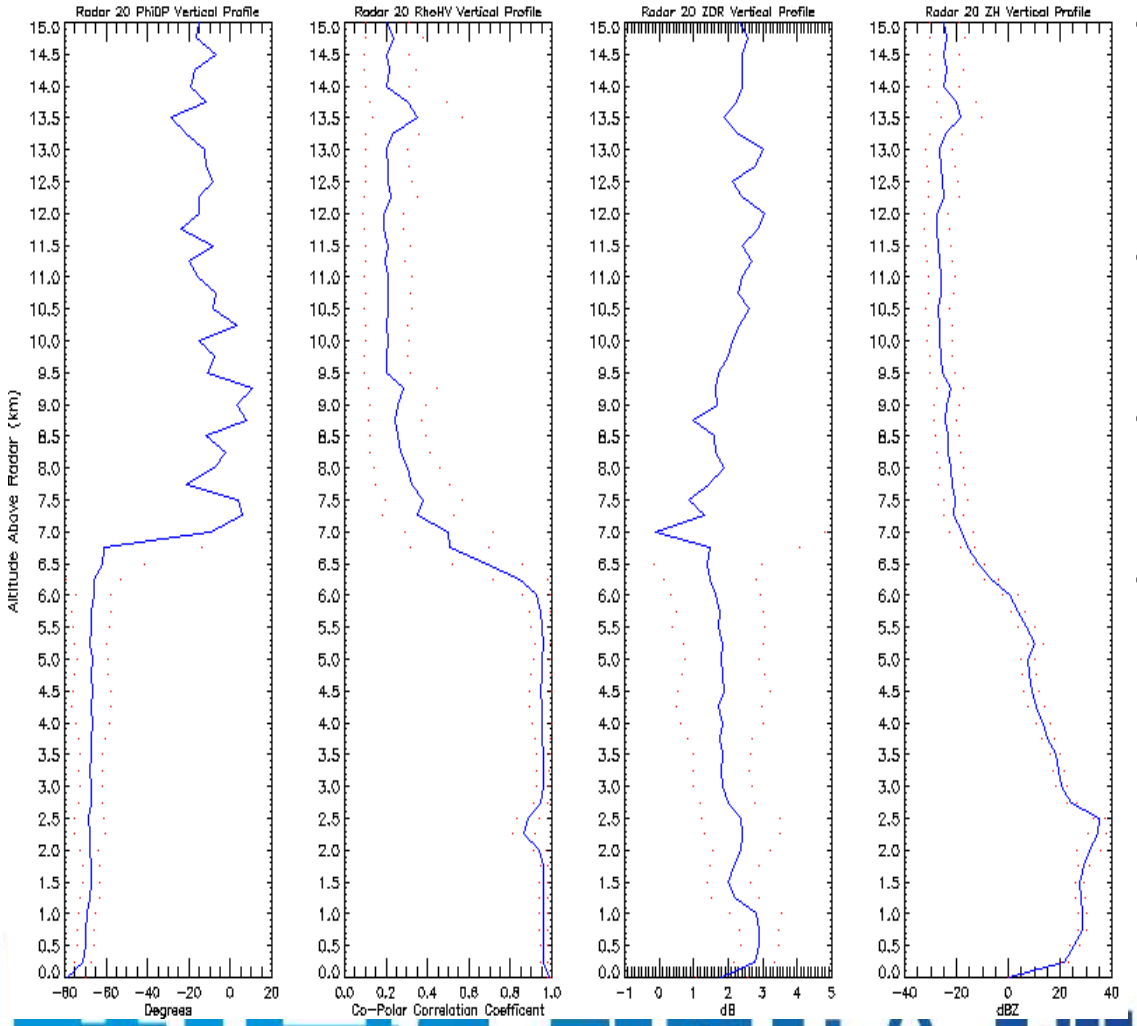
Using texture

- The huge phase shifts mean that texture of Φ_{DP} (9pts or along ray) rejected rain as clutter.



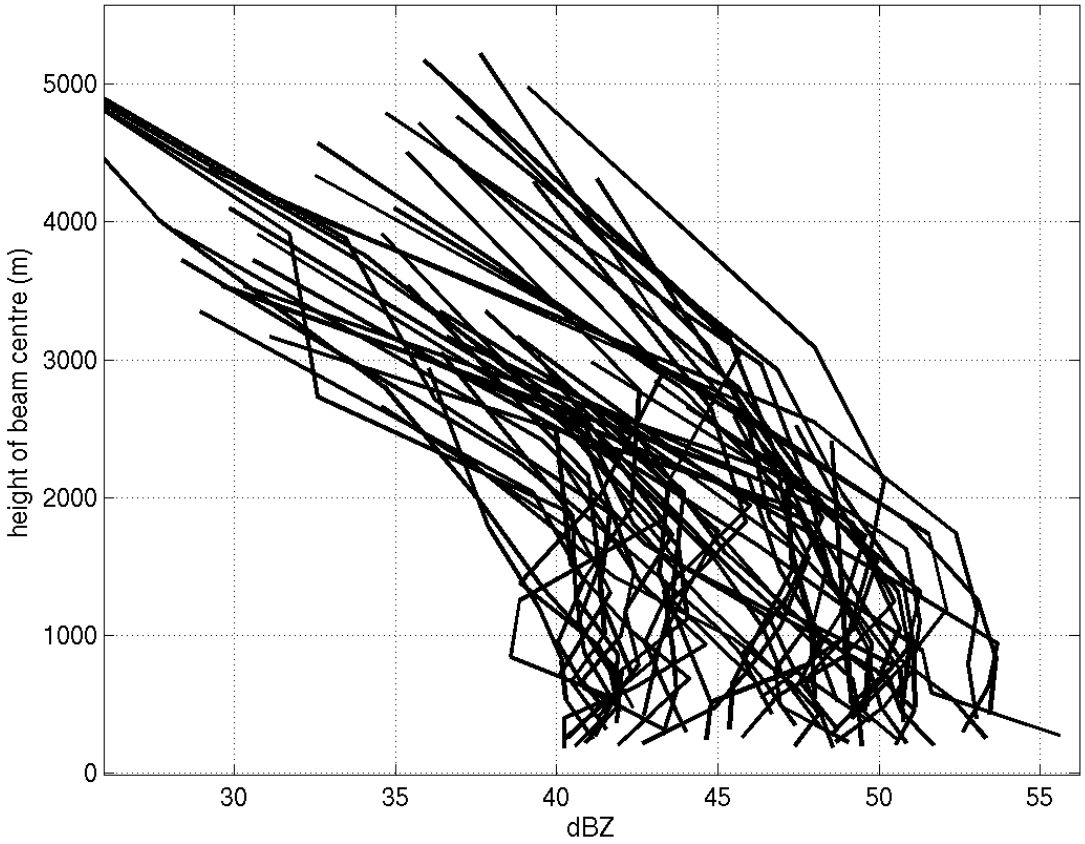
Effects of Vertical structure

Vertical scan data from Wardon Hill



- "Bright-band" where ice melting to water (0° C)
- Flat below bright band
- -3 dB/km above bright band.
- Not accounted for in the is case – usually dealt with in Radarnet VPR code

Vertical Profile



- Vertical profiles taken from beams 0-5 close range
- Falls off strongly above 2000m
- Beams above this will underestimate rain.
- 0.8^{o} beam at 95km is 2km high and 2km broad.

Summary

- Attenuation of the radar beam is more important at X-Band
- Dual polarisation technology offer some scope to identify and correct for this effect.
- Algorithm using dual polarisation attenuation correction are limited – heavy rain can cause total loss of the signal at which point correction will not be possible.
- Data clean-up is important and can be difficult even with Dual-pol. technology

Questions and answers