

# Generator of Empirically-Based Synthetic Radar-Rainfall Data

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# Objective and Definitions

## Development of a generator of empirically-based synthetic radar-rainfall fields

- **True Rainfall:** Amount of rain-water falling on a specified area in a specified interval
- **Radar-Rainfall (RR):** An approximation of the True Rainfall based on radar data
- **RR Uncertainties:** All discrepancies between RR and the corresponding True Rainfall
- **Actual Rainfall (RA):** Approximation of True Rainfall, based on rain-gauge measurements, used to evaluate RR

# Mathematical Apparatus

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$$R_a = h(R_r) \cdot e(R_r)$$

*where:*

- $h(R_r) = E [R_a \mid R_r = r_r]$

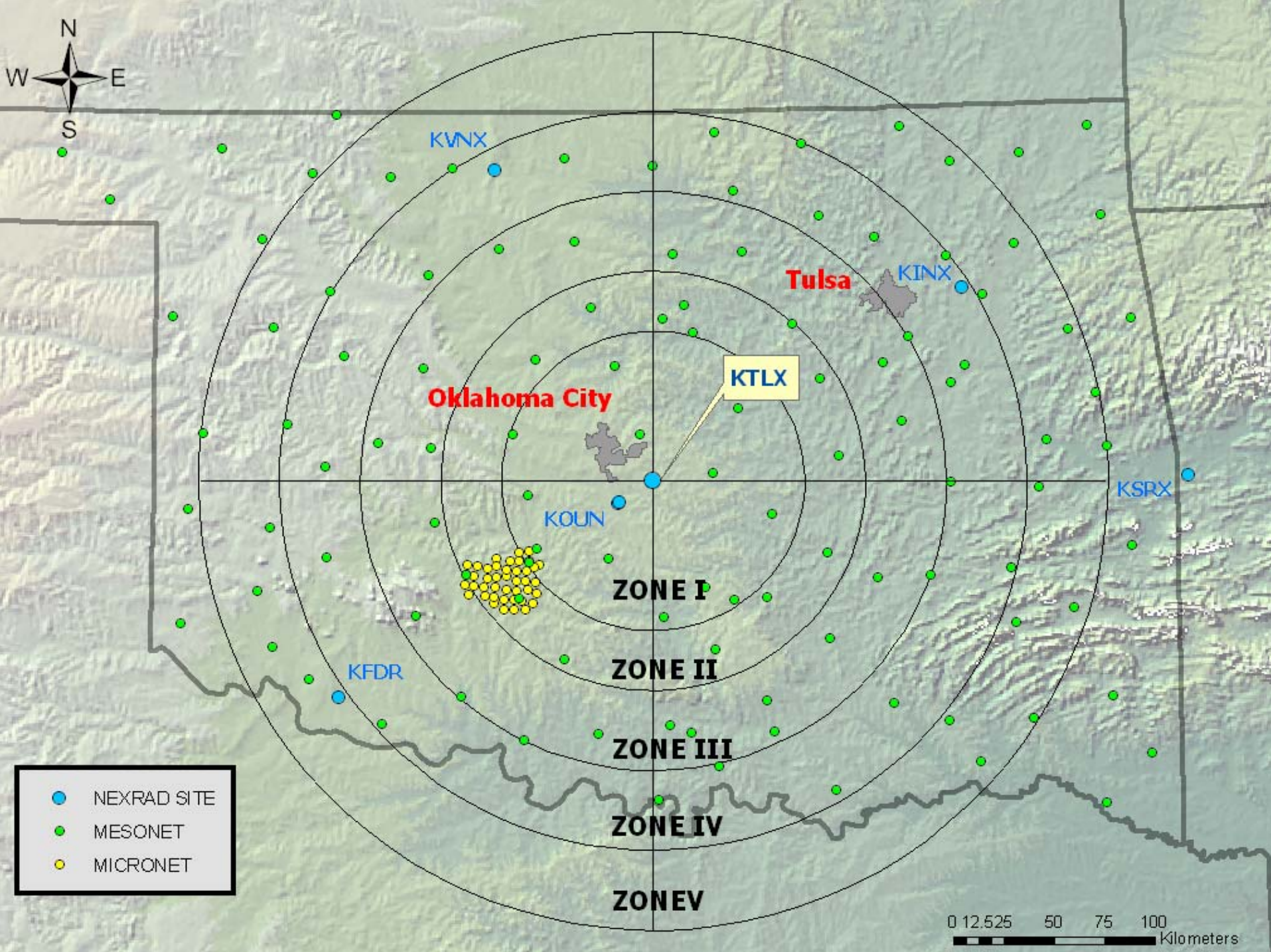


deterministic function

- $e(R_r) = R_a / h(R_r)$



random component



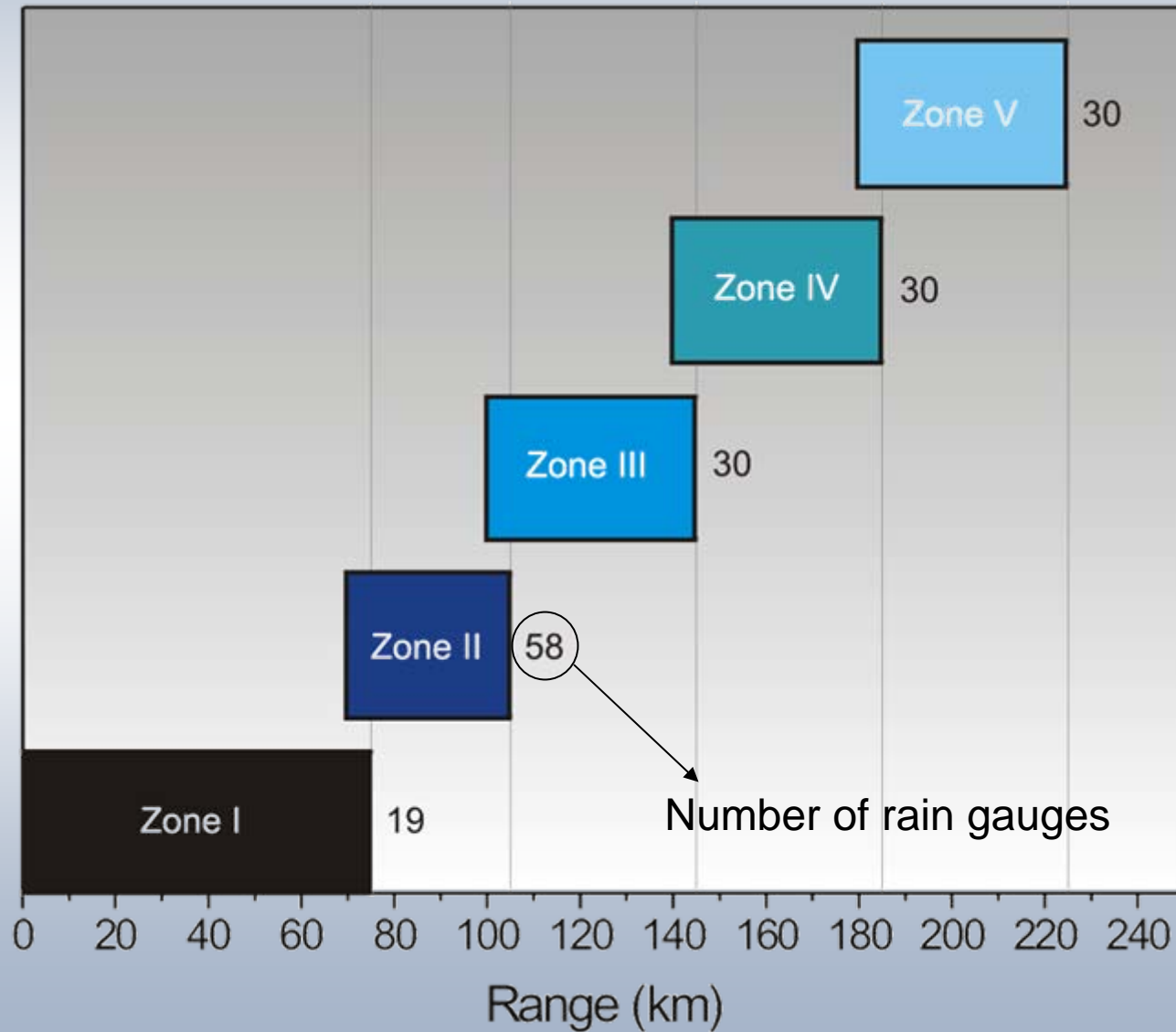
- NEXRAD SITE
- MESONET
- MICRONET

0 12.5 25 50 75 100 Kilometers

# **Oklahoma Data Results**

**(after considerable QC/QA)**

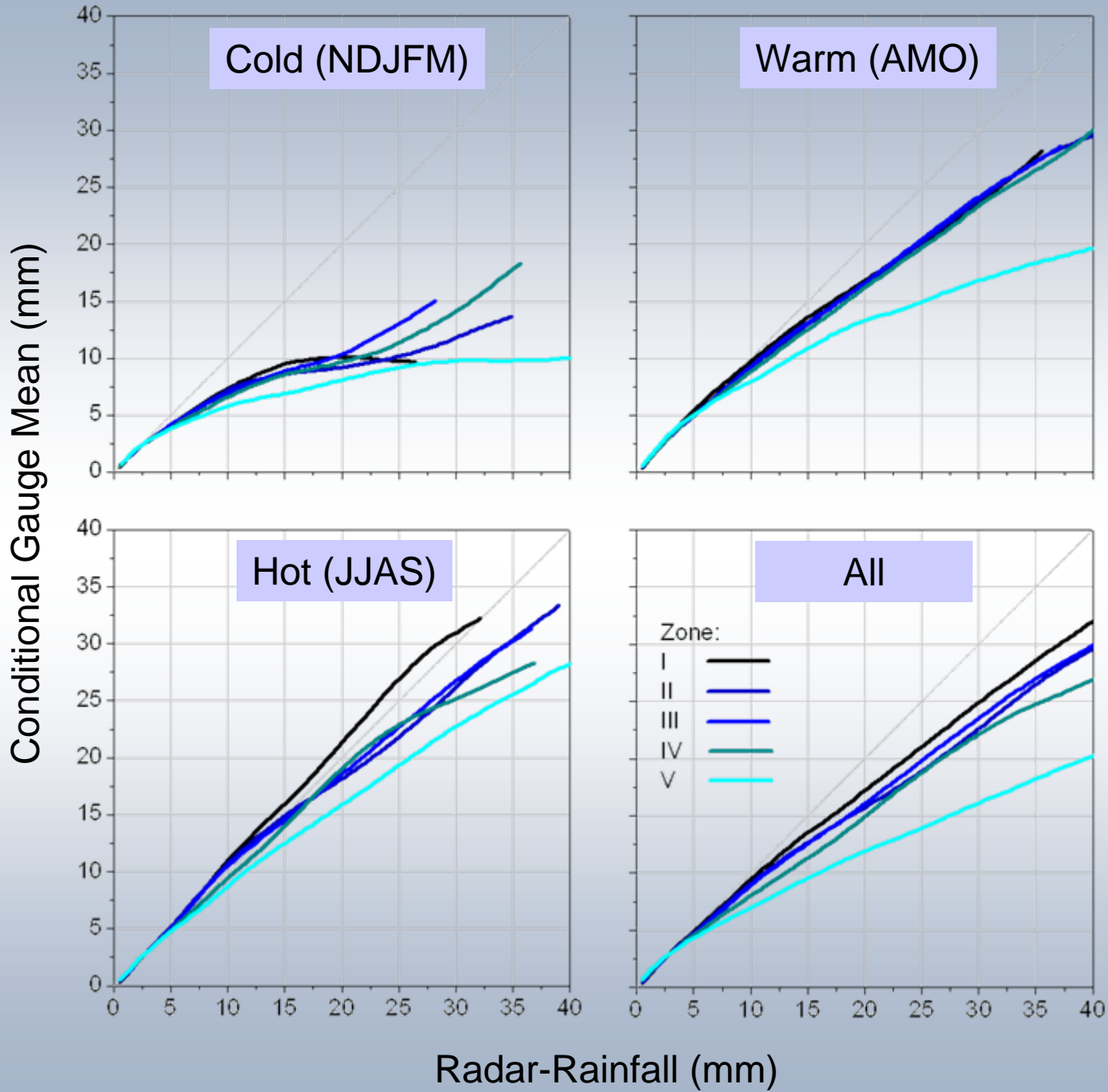
# Range effect

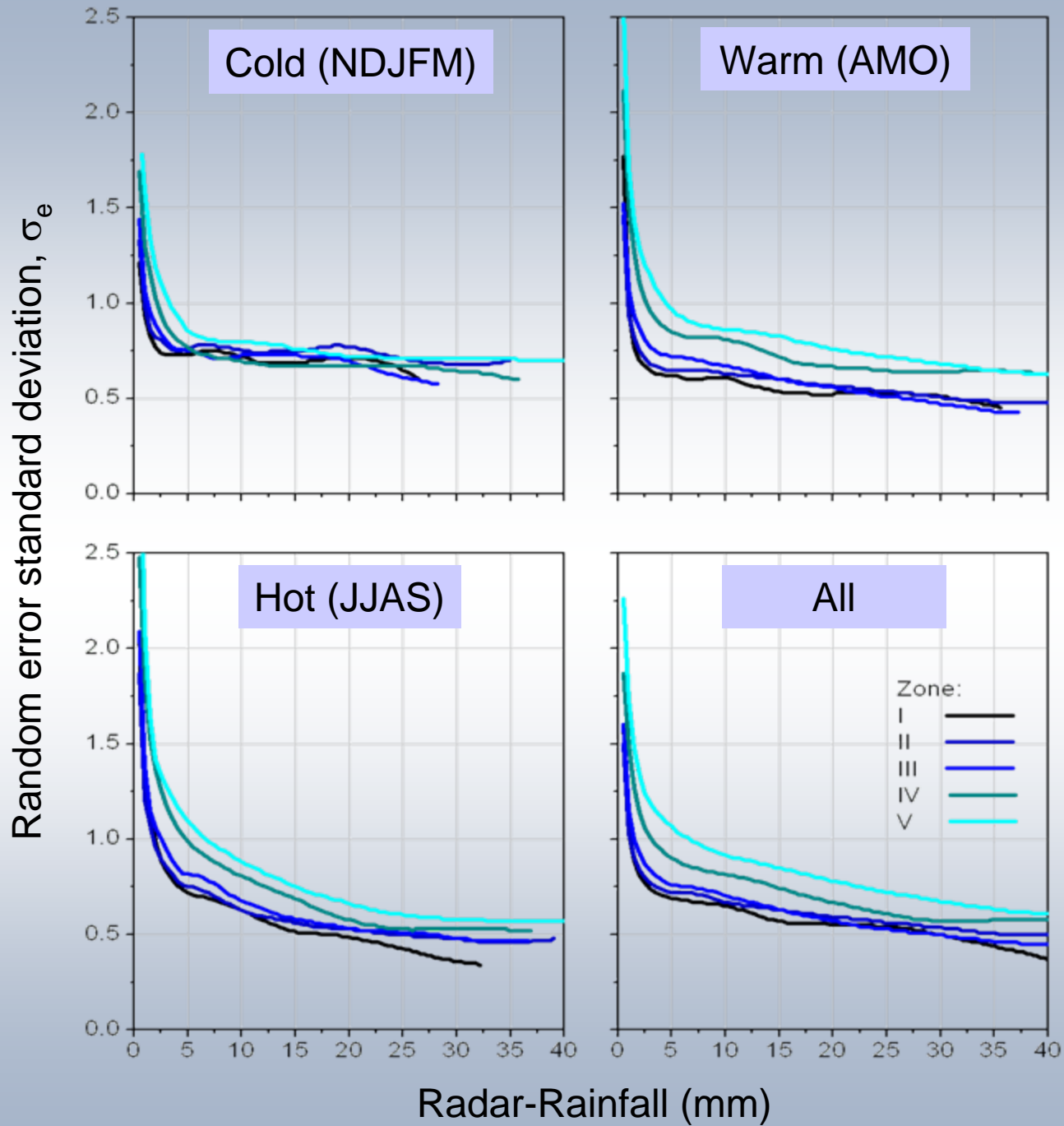


# Overall Bias

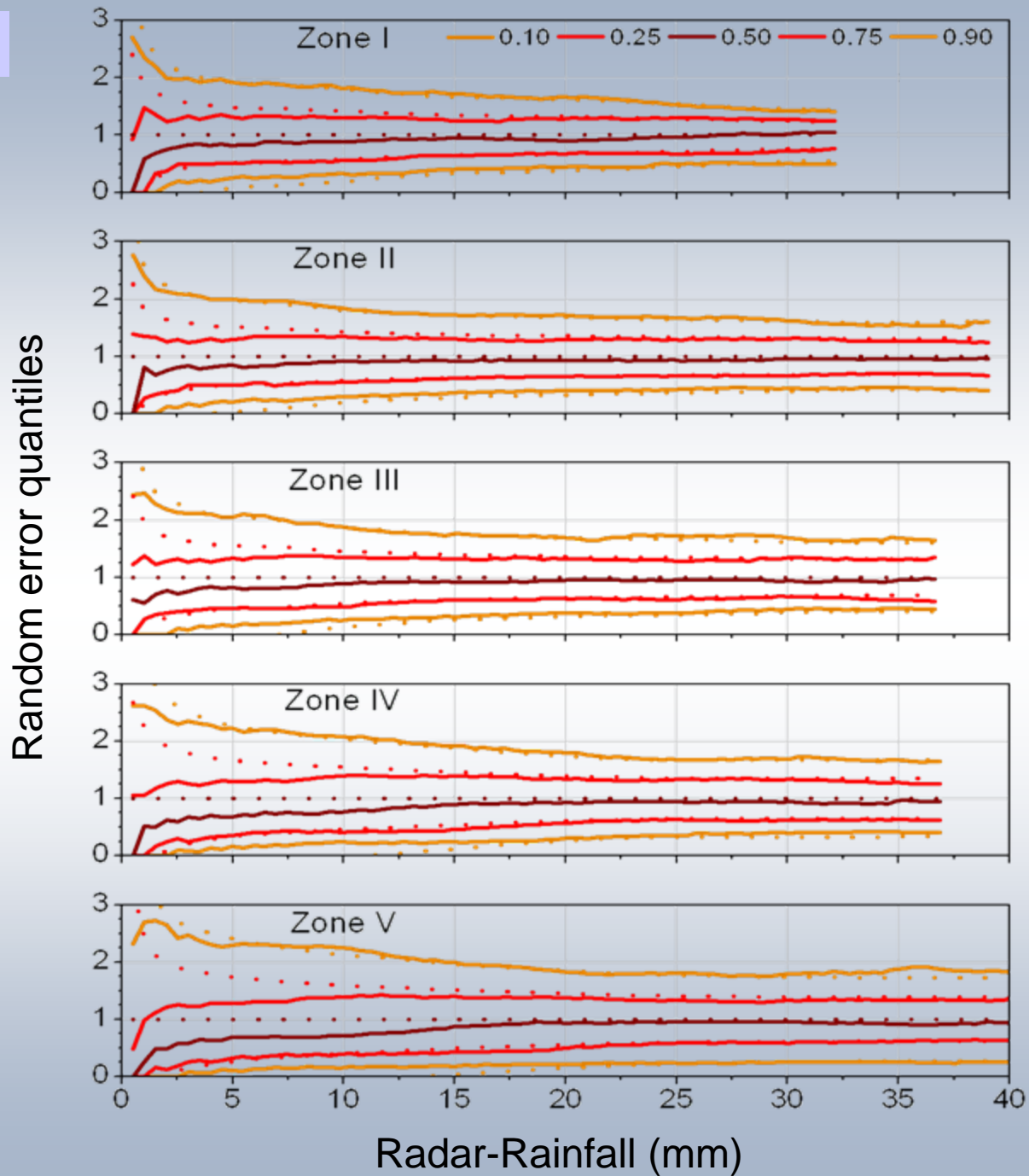
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Hourly Data	Cold (NDJFM)	Warm (AMO)	Hot (JJAS)	Entire dataset
<i>Zone I</i>	0.95	0.78	0.76	0.82
<i>Zone II</i>	0.88	0.76	0.73	0.78
<i>Zone III</i>	0.87	0.68	0.65	0.72
<i>Zone IV</i>	1.29	0.78	0.65	0.83
<i>Zone V</i>	2.33	1.11	0.75	1.12



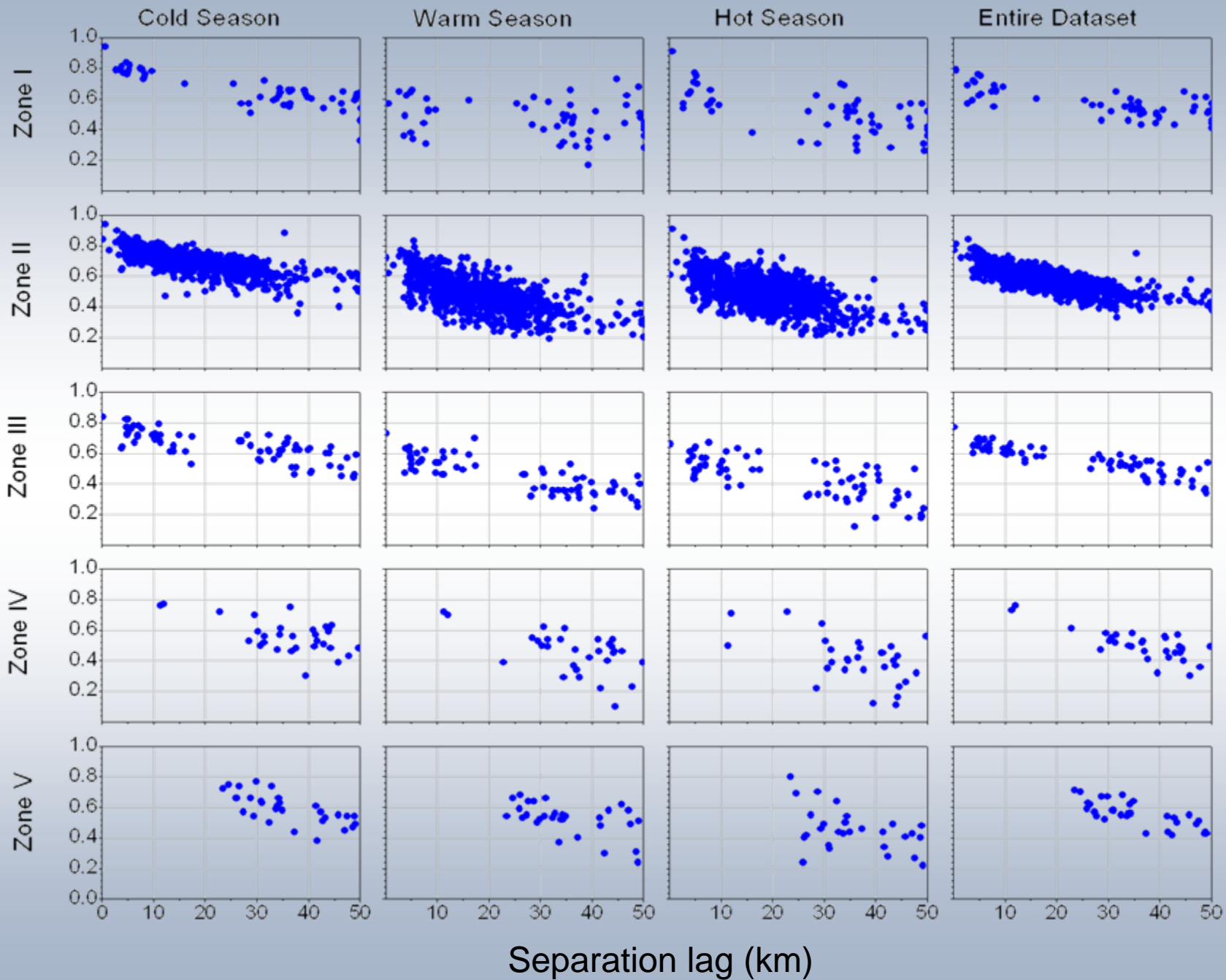


Hot (JJAS)



Radar-Rainfall (mm)

Spatial correlation of the random error,  $\rho_e$

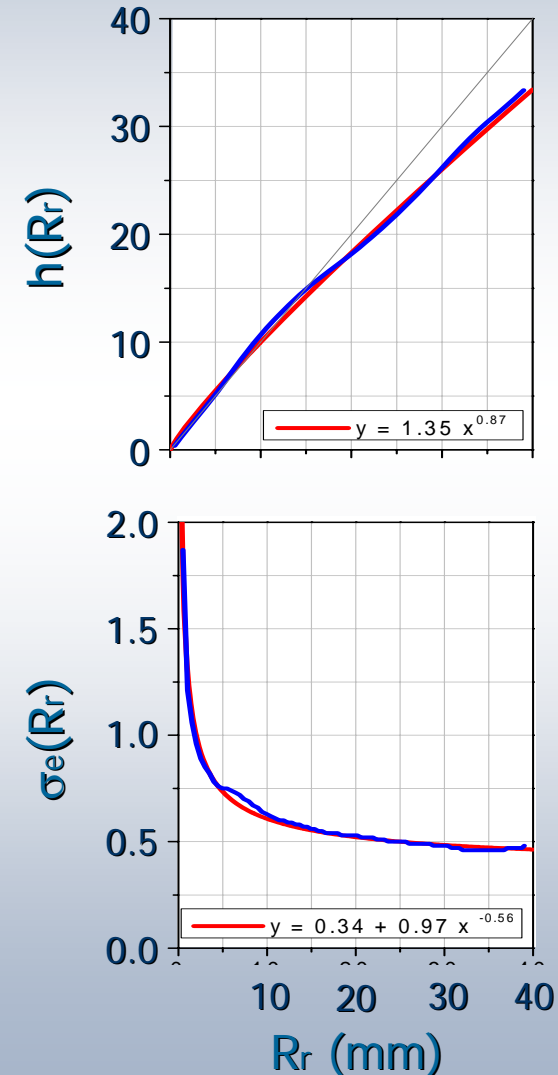




# Model Fitting

$$R_a = h(R_r) \cdot e(R_r)$$

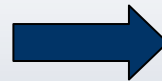
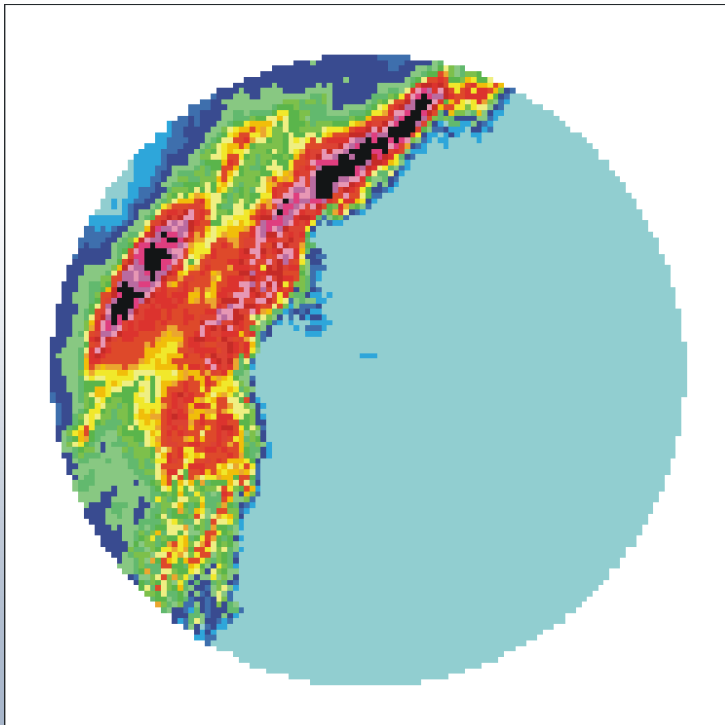
- Deterministic distortion function
  - $h(R_r) = a (\text{Bias} \cdot RR)^b$
- Random component  $\sim N[1, \sigma_e(R_r)]$ 
  - $\sigma_e(R_r) = c + d (\text{Bias} \cdot RR)^e$
  - three-parameter exponential function for the correlation in space and time



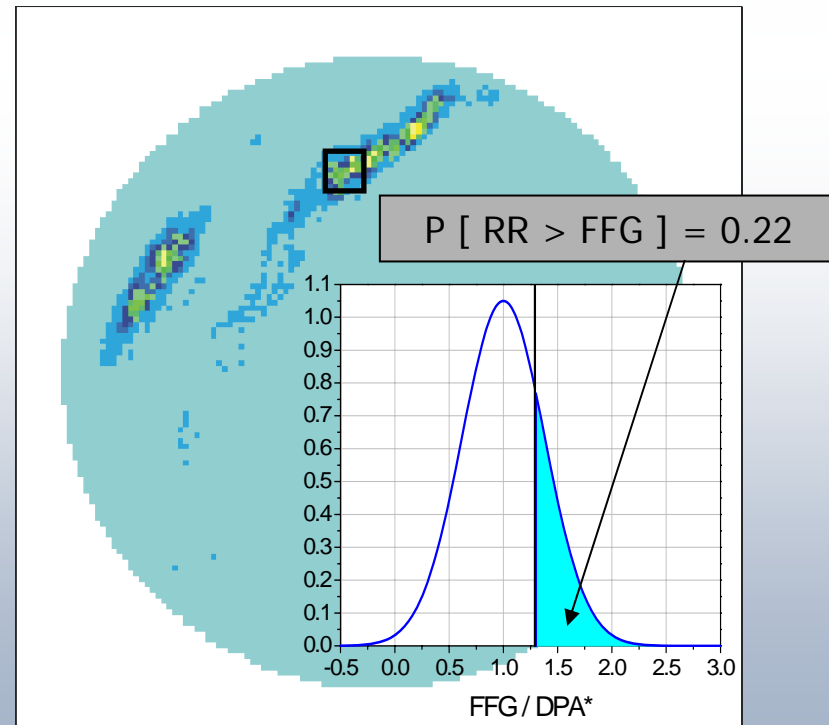
# Scenario 1: Probability Map

The models allow answering probabilistic question:  
Given a radar-rainfall accumulation map, what is the probability that the true rainfall exceeds a certain threshold (e.g., FFG value) over a basin?

## Radar scan



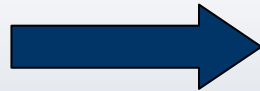
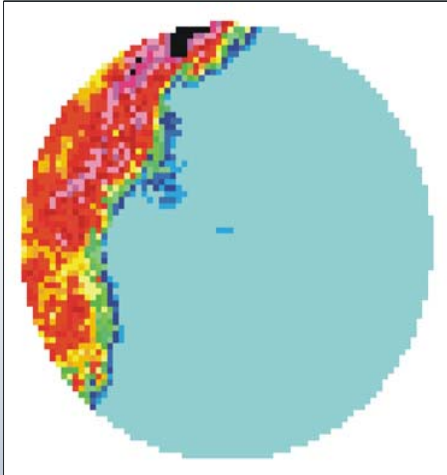
## Probability map



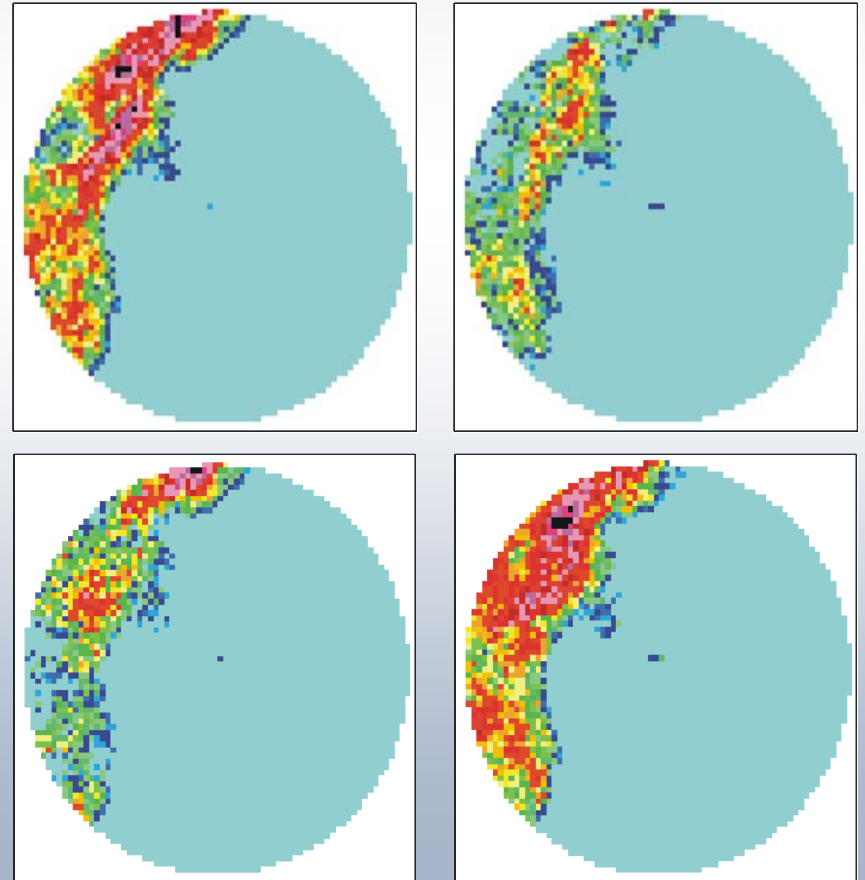
# Scenario 2: Ensemble generator

The models allows generating a space-time ensemble of synthetic radar rainfall fields, congruent with the error model's characteristics

**Radar scan**



**Synthetic radar fields**



# Conclusions

- **Realistic error model based on extensive empirical analysis**
- **Confirmation of strong range effects and seasonal dependence**
- **Strong dependence on radar-rainfall**
- **Random component correlated in space and time**
- **The model allows:**
  - **estimating the probability of the true rainfall to exceed some arbitrary thresholds**
  - **generating a space-time ensemble of empirically-based synthetic radar rainfall fields**

The background of the slide is a composite image. The top half shows a bright blue sky with large, fluffy white clouds. The bottom half shows a close-up of a surface covered in numerous water droplets of various sizes, creating a textured, shimmering effect.

**Thank You!**

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**The End**