Polarimetric Radar and NWP Synergies

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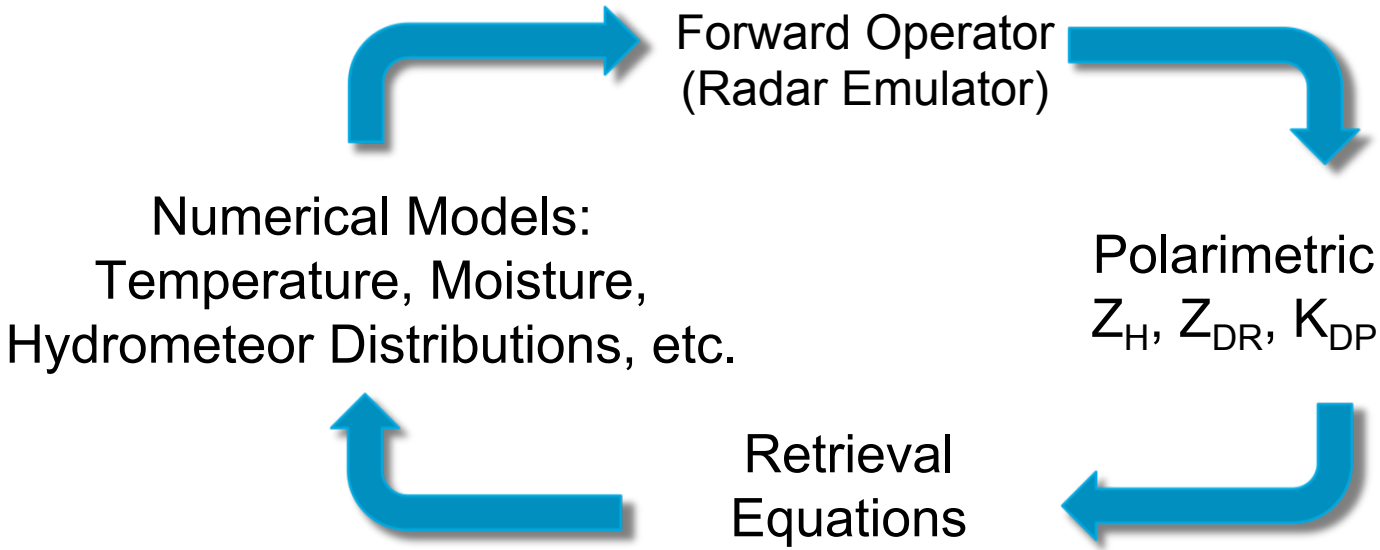
Numerical Model + Radar Data Interaction



Many of the most "polarimetrically interesting" signatures occur where complexities and uncertainties can be significant.

Radar quantities can be affected by

- Size distribution
- Water fraction and distribution*
- Particle density*
- Shape, canting angle, and variability*
- Radar frequency

* Generally not predicted

Forward Operators

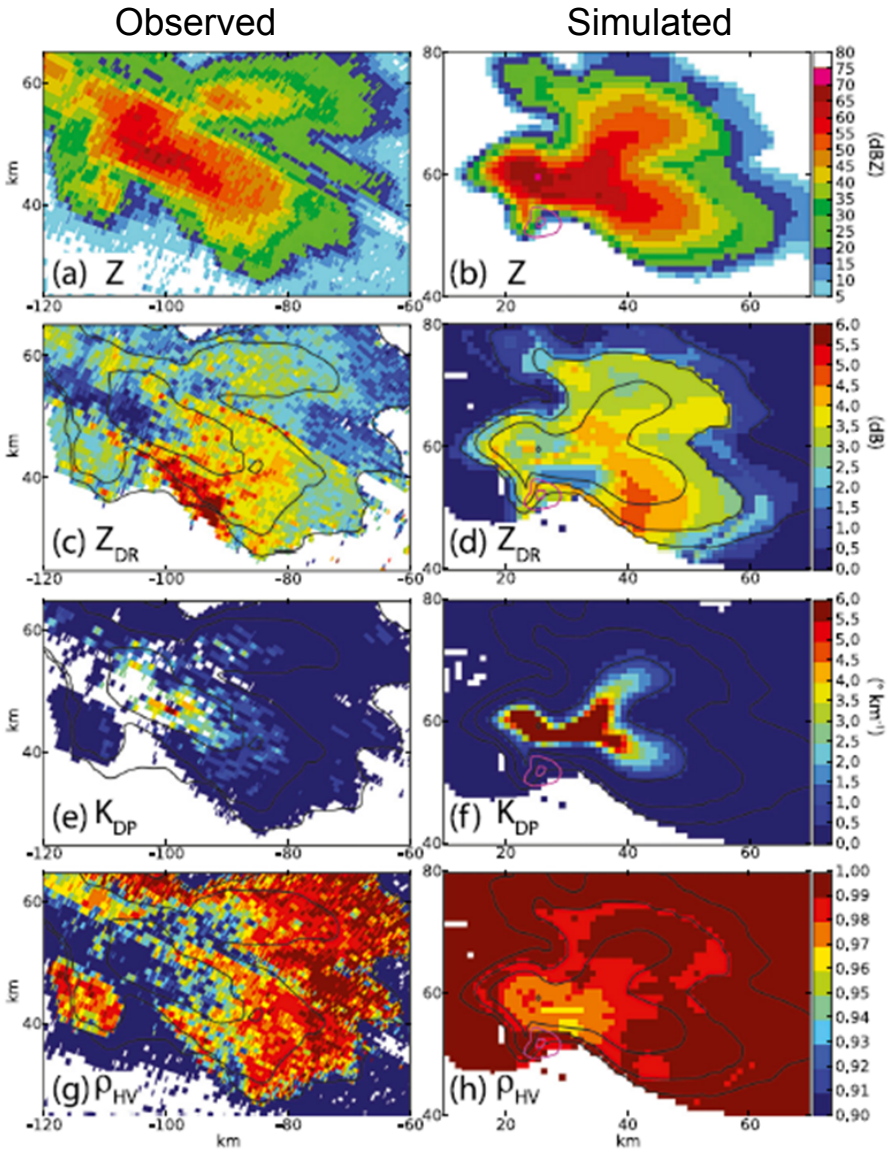
Jung et al. (2010); Ryzhkov et al. (2011)

Valuable uses:

- Evaluation of models
- Study of relationships between radar signatures and microphysical processes, etc.
- Development of data assimilation (using radar data directly in model)

Many potential error sources:

- Model (e.g., fixed density, no water fraction / wet ice, “simple” size distributions)
- Forward operator (e.g., fixed temperatures in calculations, water fraction routines)



Dawson et al. (2014)

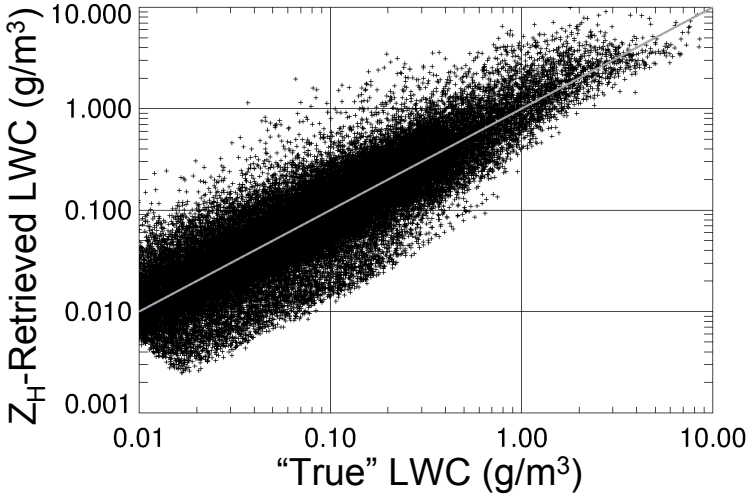
Microphysical Retrievals

Polarimetric information can aid estimates of rain and ice characteristics

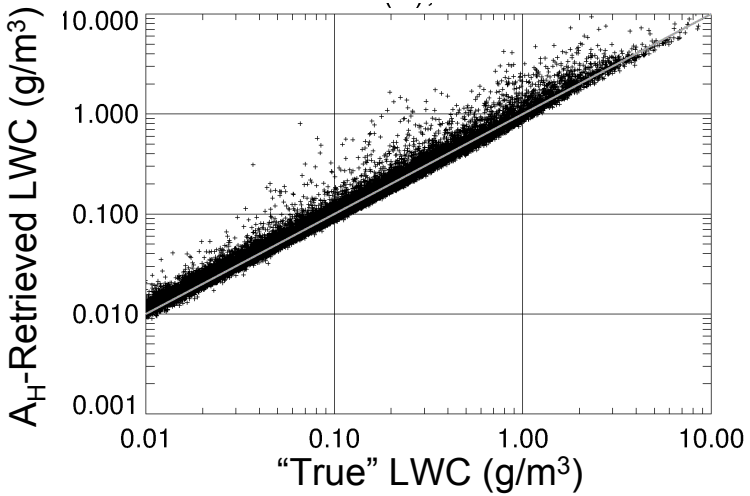
Naturally-occurring variability in hydrometeor distributions means that “one size fits all” retrieval equations are often suboptimal

Liquid Water Content (LWC)

Single Polarization (Conventional)



Dual Polarization

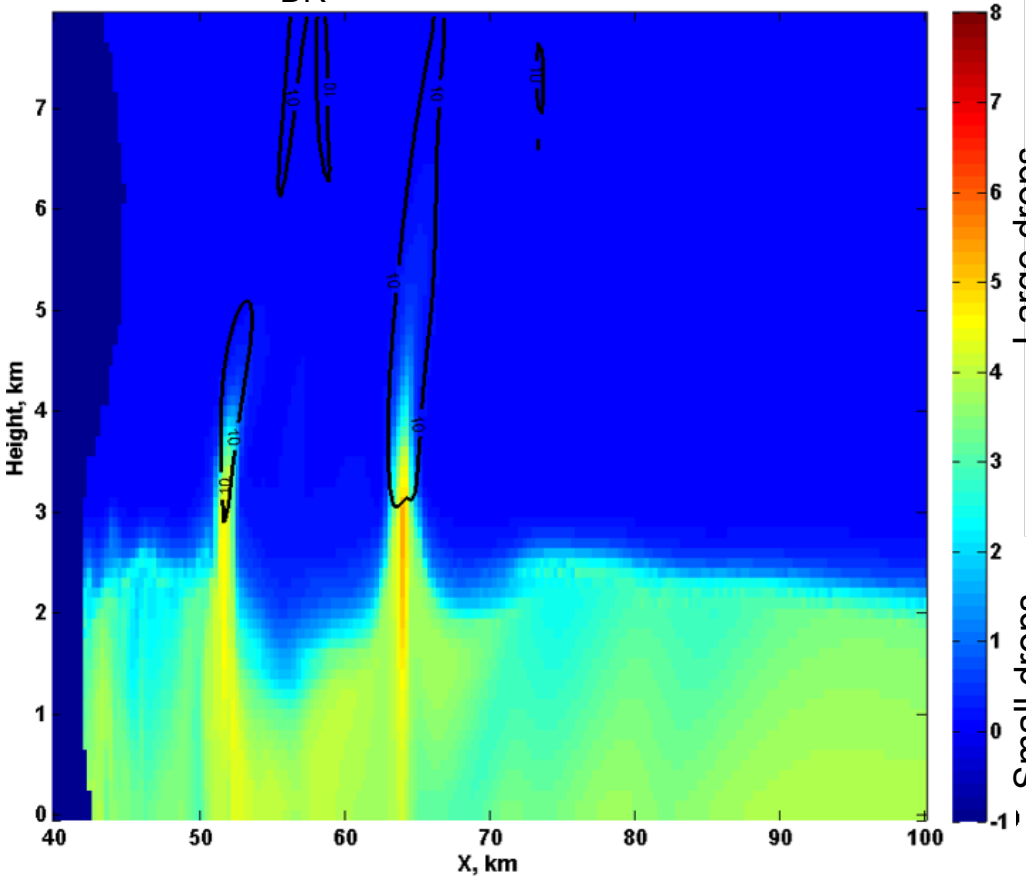


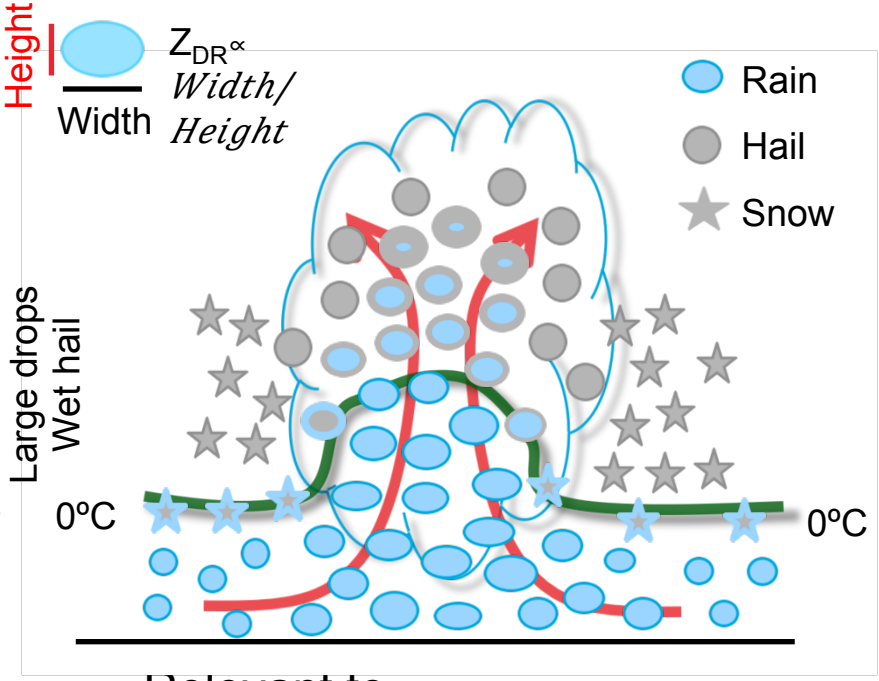
Above – Less scatter = better

Z_{DR} Columns – Example of Potential Utilization

Hebrew University Cloud Model

Z_{DR} (dB) W (contoured)



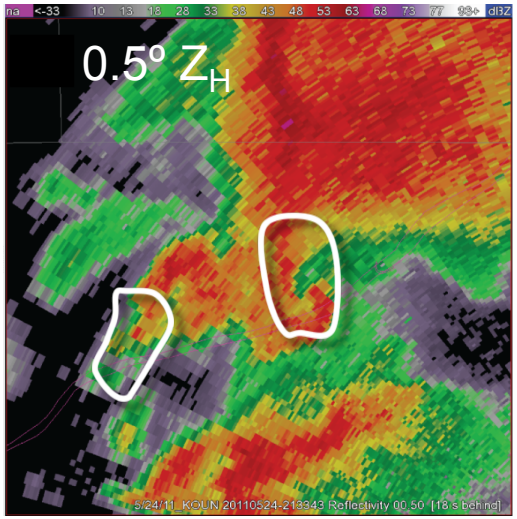


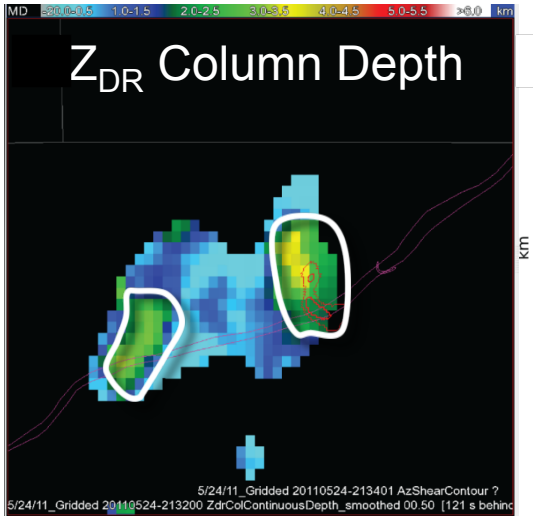
Relevant to

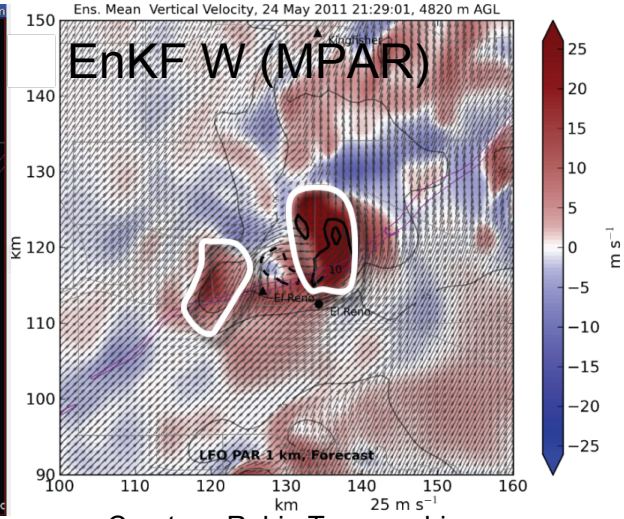
1. Operations – large hail growth, updraft evolution (intensification/dissipation)
2. Research – identify regions and extent of latent heating associated with condensation

See Kumjian et al. (2014) and Snyder et al. (2014)

24 May 2011
Violent tornado in OK

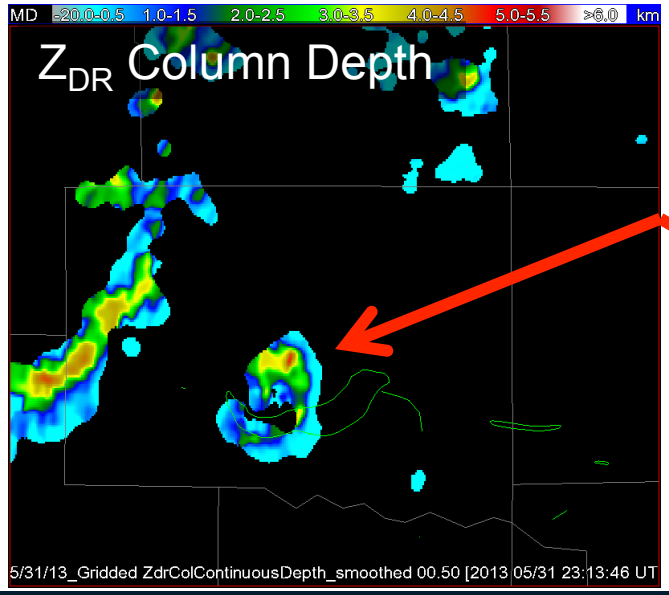


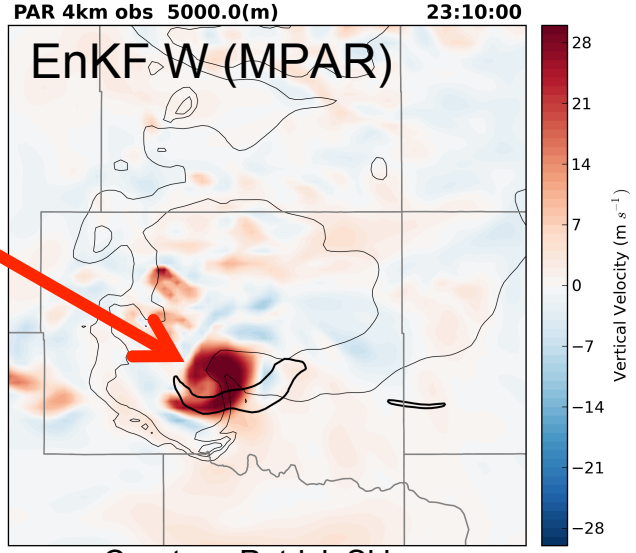




Courtesy Robin Tanamachi

31 May 2013
Intense tornado in OK





Courtesy Patrick Skinner

Summary

Build collaborations between those in the cloud modeling and radar communities to leverage expertise

- Research (e.g., post-event analysis, sensitivity experiments)
- Operations (e.g., R2O-focused algorithm development)

Continue to **use insight gained** from modeling efforts coupled with forward operators to **establish new relationships between observed and unobserved quantities**

- Z_{DR} columns → updrafts (latent heating, etc.)
- Tendencies/Structures of Z, Z_{DR}, and K_{DP} → evaporation, aggregation and accretion, etc.
- Polarimetric data and microphysical retrievals
  - Hydrometeor classification → focus hydrometeor distributions (e.g., apply different relationships depending upon inferred hydrometeor composition)
  - Retrieved drop-size distributions