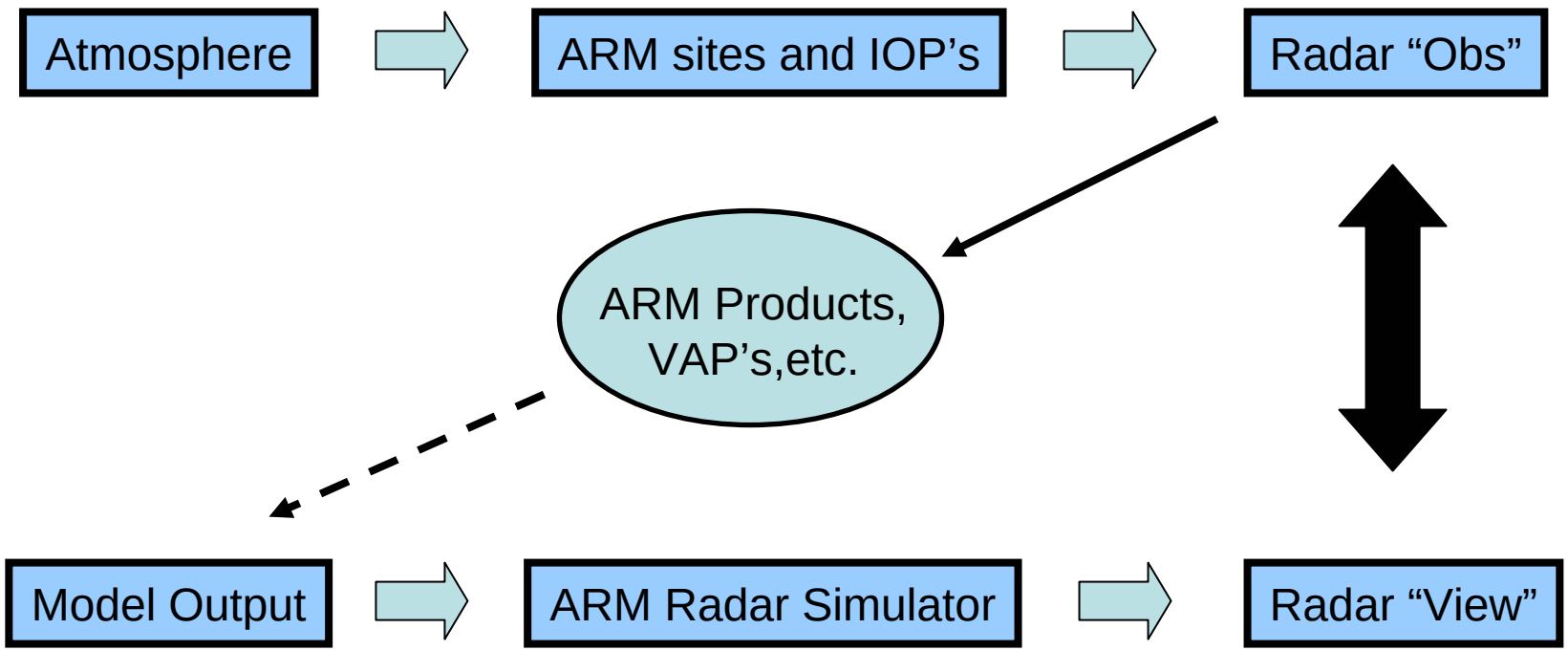
# ARM Radar Simulator

P. Kollias, E. Luke, E. Clothiaux and S. Klein

Combined CMWG/CPWG Meeting
March 26, 2007 ARM Science Team Meeting

The ARM Radar Simulator (ARS) offers a different path for direct comparison between modeled and observed clouds and precipitation at the ARM sites and IOP's.



# Radar Observables at the ARM sites

**Profiling MMCR/WACR**

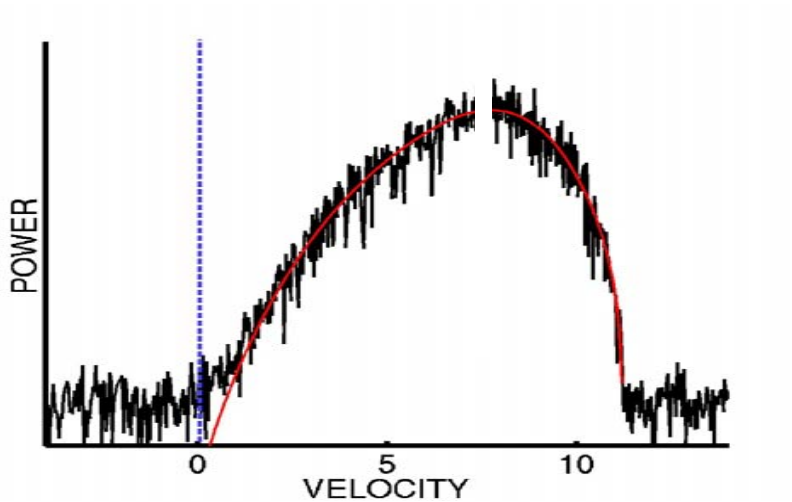
**Reflectivity (Z):** Used for cloud boundary determination (ARSCL input) and LWC profile retrieval. Particle size and concentration contribute to Z, not clear how to partition their contribution although some quantitative boundaries exist e.g. drizzle threshold.

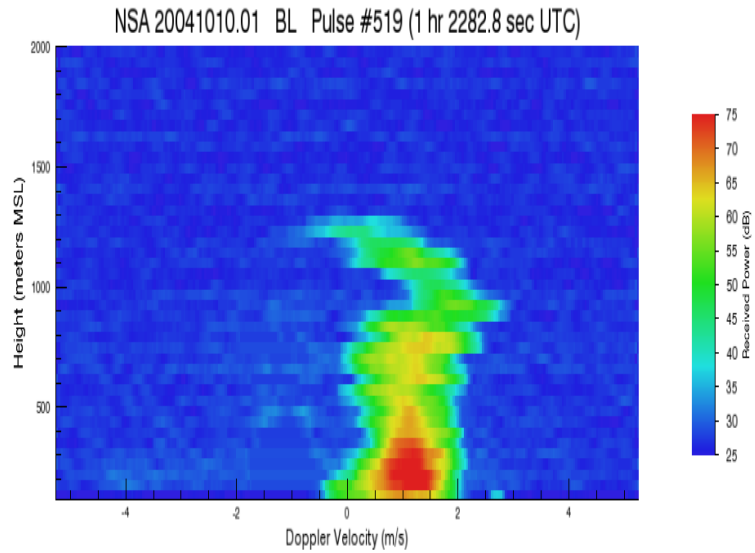
**Mean Doppler Velocity (V) and Spectrum Width ($\sigma$):** Few PI's use these variables (e.g. Mace, cirrus retrievals), not well measured by the ARM program until the recent upgrades. Conditionally can be used to retrieve information on DSD width, shape and turbulence.

**Linear Depol. Ratio (LDR) and Circular Depol. Ratio (CDR):** Added lately to the suite of radar observables. Useful for identifying particle melting and non-sphericity.

# Radar Doppler Spectrum

The returned power to the radar represents a combined signal from a variety of targets (distributed targets) in the radar pulse volume. The return power is distributed over a range of Doppler velocities. This is known as the Doppler spectrum



slide provided by Clothiaux

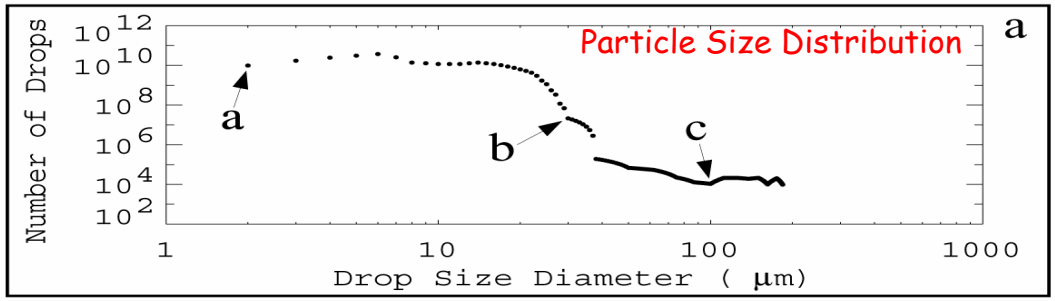
N(D)

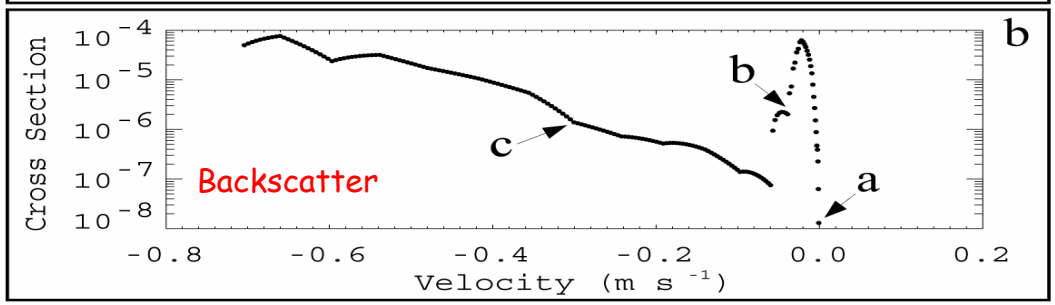
σ(D)

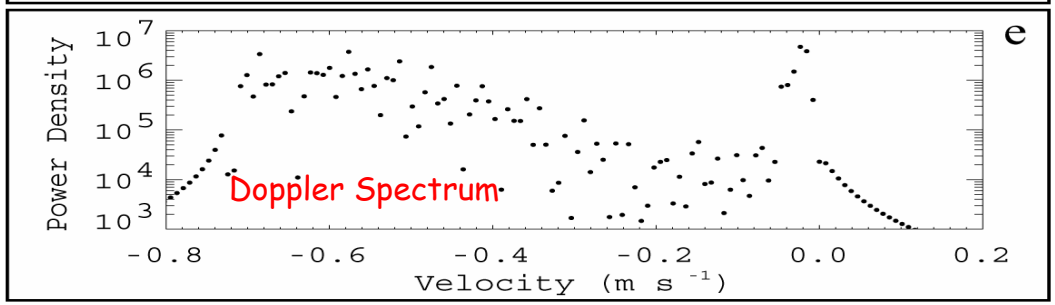
S(V)

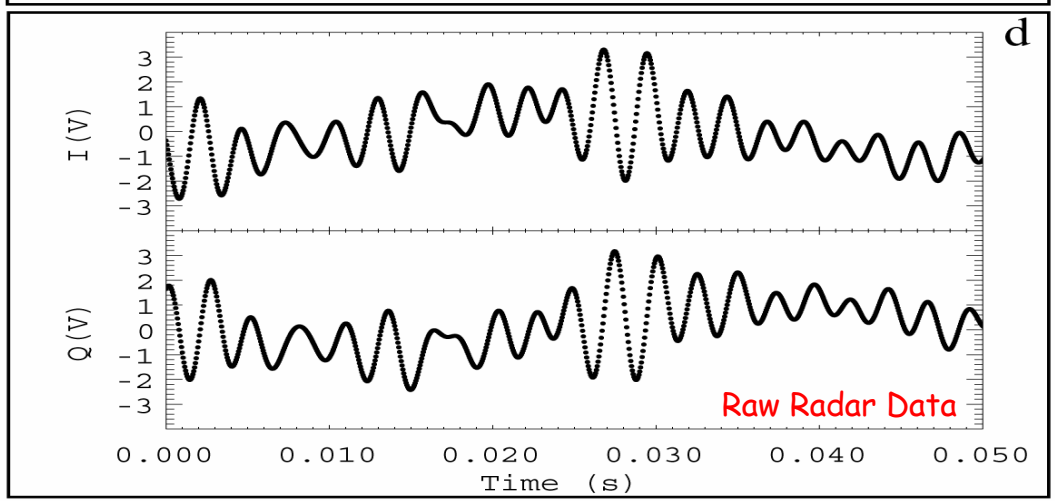
I

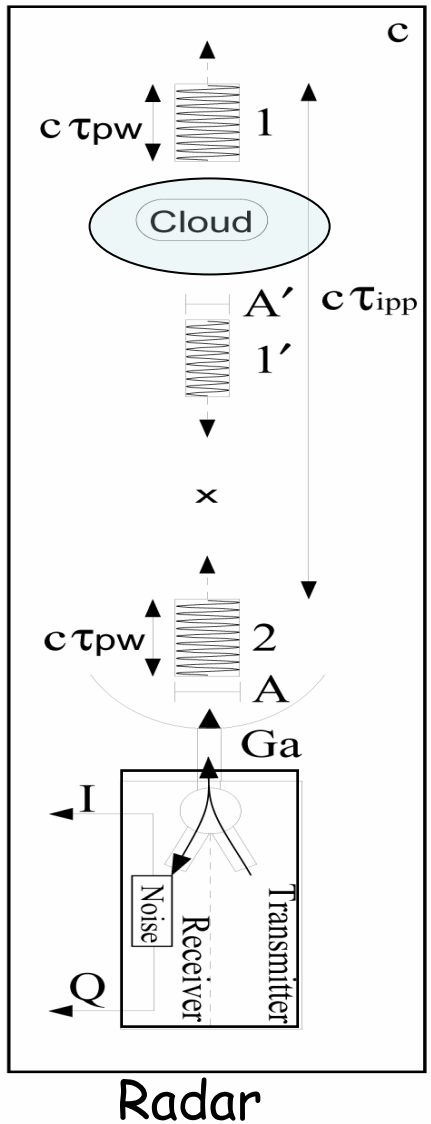
Q



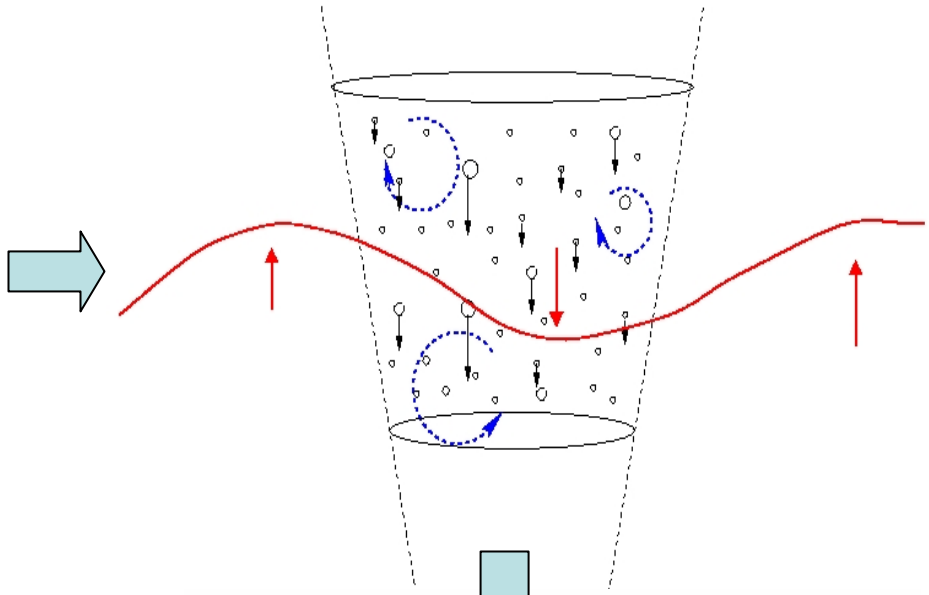



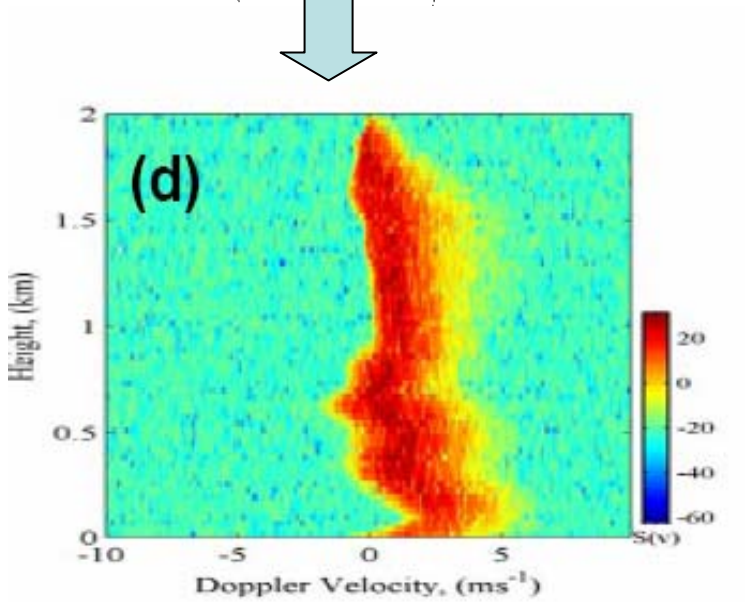
**Model Input (x,y,z):**

U,V,W : wind components
T : temperature
P : pressure
ρair : air density
R : water vapor mixing ratio
WC : water content
N(D) : size distribution
TKE : sub-grid turbulence intensity

**Evaluate-Constrain Model:**
Precipitation Onset
Cloud Phase
DSD shape
DSD particle size range
Sub-grid turbulence

**Doppler spectra simulation**






**Simulated Doppler spectrum**

# Scanning Radar Simulator

## Radar Module

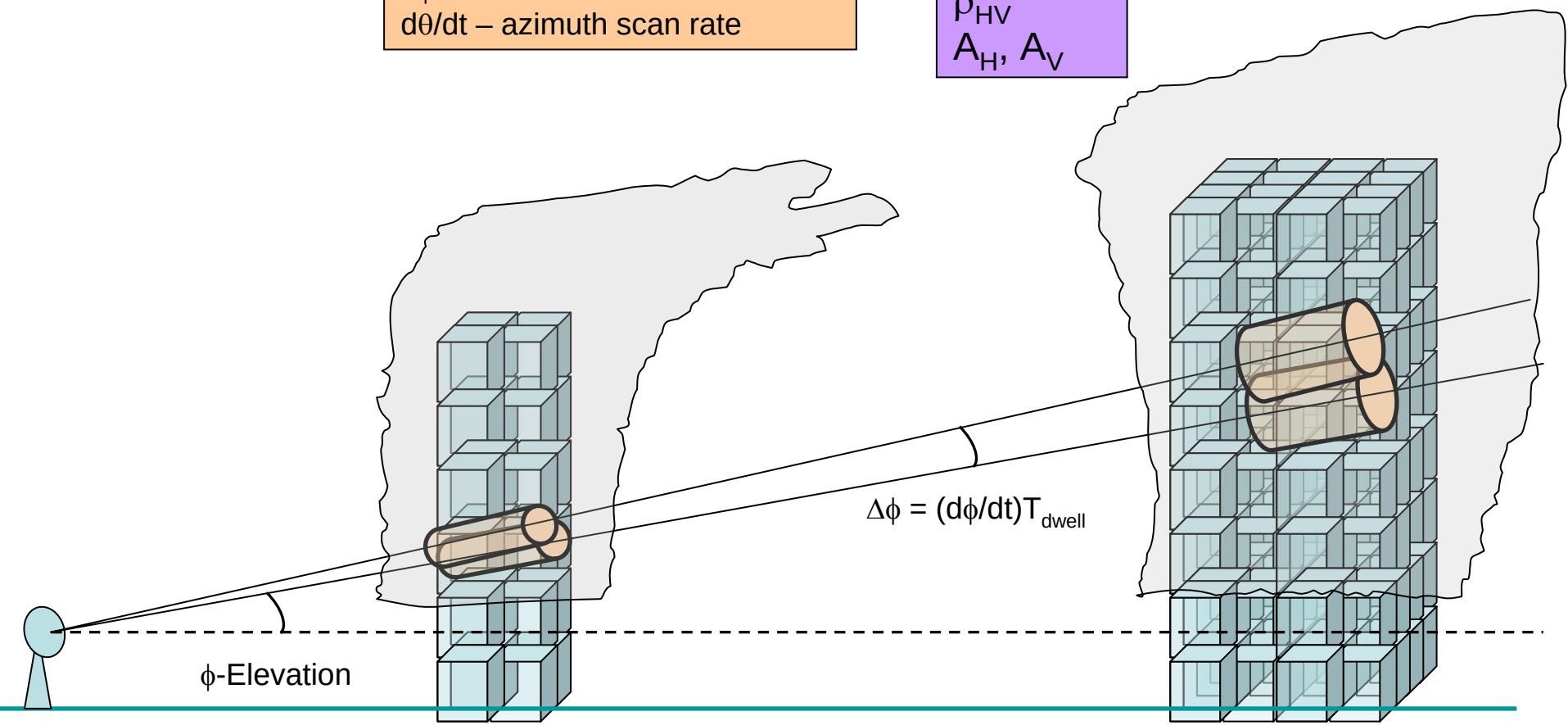
- λ- wavelength
- Sensitivity
- Range Resolution
- 3-dB Beamwidth
- PRF

## Scanning Module

- VPR – Vertically Pointing Radar
- PPI – Plain Position Indicator
- RHI – Range Height Indicator
- $[X_o, Y_o, Z_o]$ – Initial Position
- $[U_R, V_R, W_R]$ – Radar Motion
- $d\phi/dt$ – elevation scan rate
- $d\theta/dt$ – azimuth scan rate

## Radar Observables

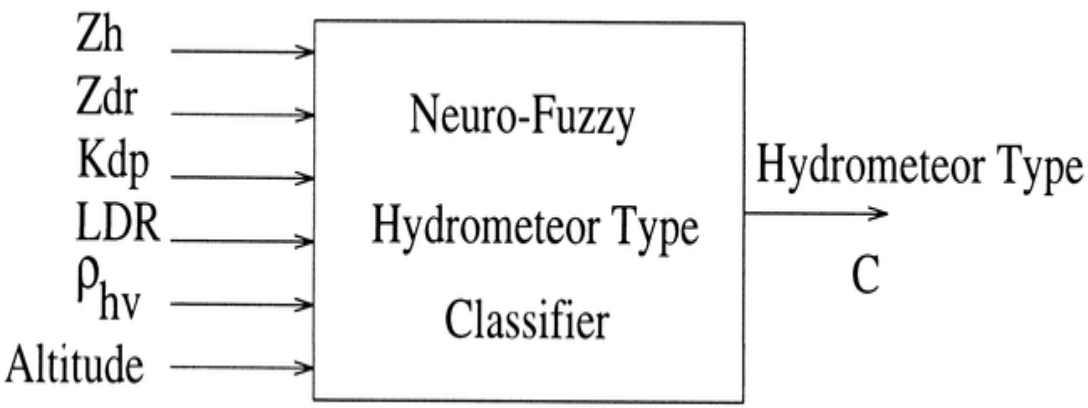
- Z, V, SW
- ZDR
- LDR
- $K_{DP}$
- $\rho_{HV}$
- $A_H$, $A_V$



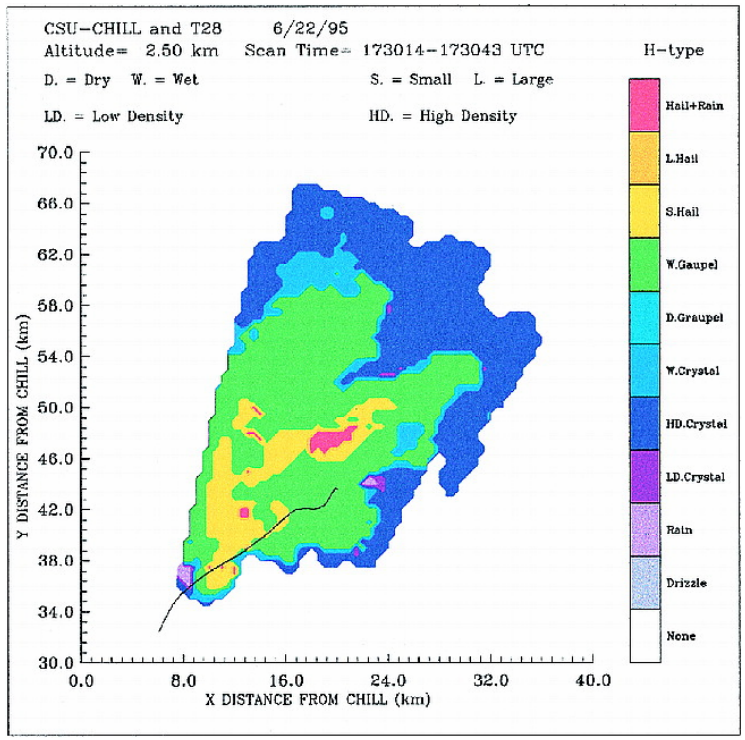
# Applications of Multi-parametric Scanning Radar Simulator

**Scanning Cloud/Weather Radars**

| | | |
|---|---|---|
| Reflectivity | Z | Size, Concentration |
| Mean Doppler Velocity | V | 3-D wind field |
| Spectrum Width | $\sigma$ | Turbulence |
| Differential Reflectivity | ZDR | Shape, Orientation |
| Specific differential phase | KDP | LWC, size |
| Linear Depolarization Ratio | LDR | Orientation, canting |

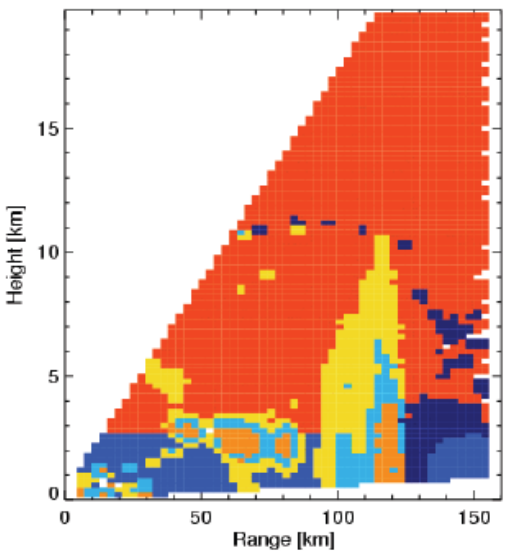


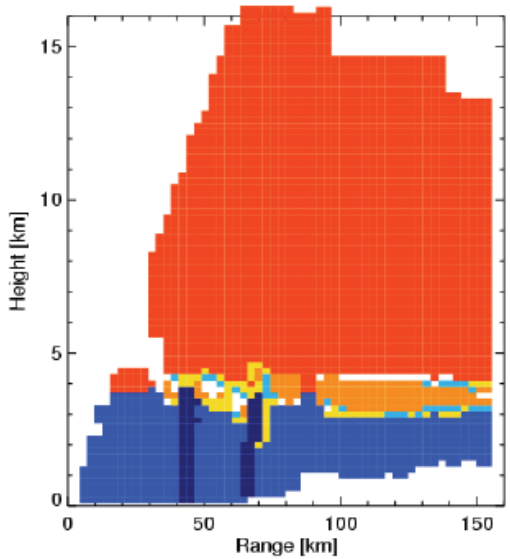

Liu and Chandrasekar (2000)



# Evaluation of microphysics scheme in LMK

Poldirad
19:23 UTC

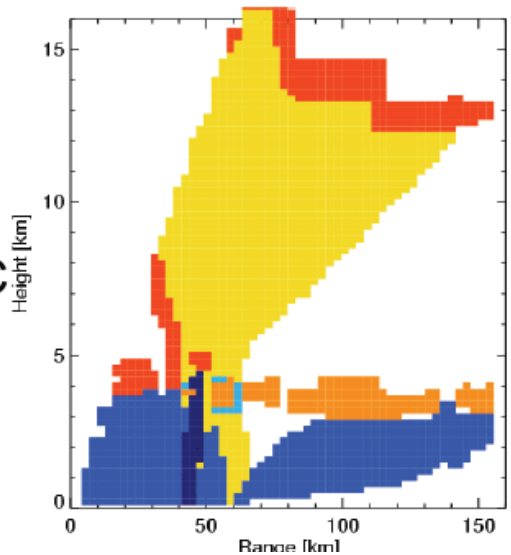


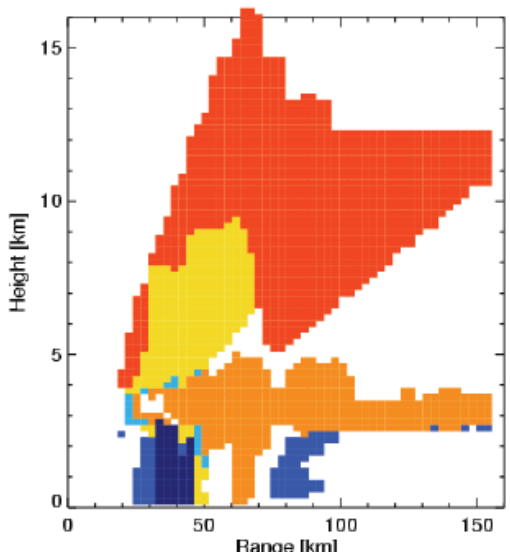





LMK
19 UTC
2 comp.

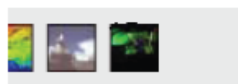
LMK 19 UTC
3 comp.





LMK
19 UTC
Thompson



Deutsche
DLR für Luft- u
in der Helml

Monika Pfeifer (DLR)

# Final comments

The ARM radar simulator will include software modules from previously developed radar simulators and ARM experience in cloud observations from profiling radars.

Documentation, visualization, software language and interface module with models are not yet developed.

Need to formulate protocols for access to and Sharing of Simulator Code/Results with ARM.

Plan workshop with NASA on radar simulators