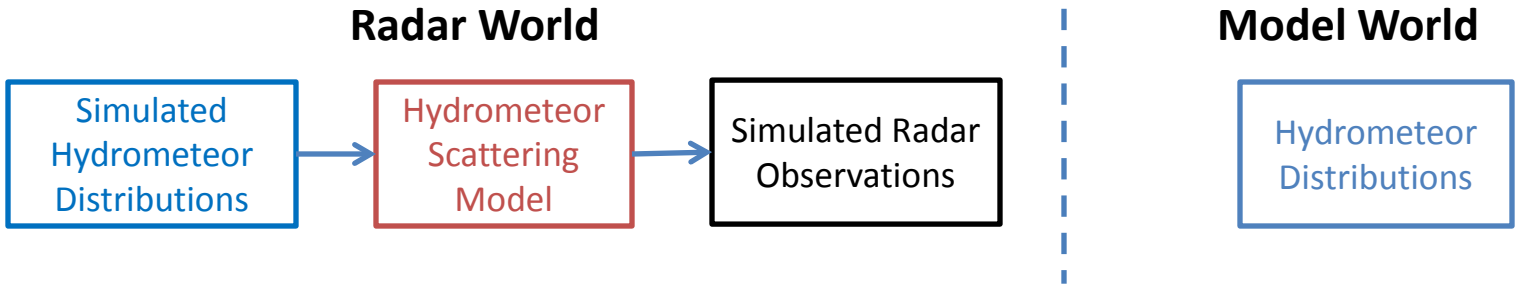
CStAT: Develop a Single Column Model-to-Radar "Translator"



Background

- In the Radar world, can simulate radar observations
  - Input: Simulated hydrometeor distribution (e.g., N(D), LWC, R)
  - Model: Scattering calculations (e.g., Mie, T-matrix, other parameters)
  - Output: Radar reflectivity, attenuation, other radar values
- In the Model world, can simulate hydrometeor distributions
  - Single- or Double-moment schemes, or discrete distributions

Problem to be Solved

- Hard for radar observationalists to understand model outputs
- And conversely, hard for modelers to understand radar observations
- There is loss of information in translating between the two worlds

Proposal

- Develop a "translator" that converts model hydrometeor distributions into radar observables
- This is a forward model problem

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Method

Phase I – Generate a Library of Single Particle Electromagnetic (EM) Scattering Tables

- EM scattering table describes how EM wave interacts with a single particle
- Scattering depends on many factors:
  - Mie vs. T-Matrix code, operating freq., habit(liquid, mixed, solid), a/b ratio, view angle, etc.
- One EM scattering table is constructed for each combination of factors
  - 1. T-Matrix, liquid drops, Thurai & Bringi (2005) a/b ratio, 90° view angle, 5° canting, 20°C
  - 2. T-Matrix, liquid drops, Thurai & Bringi (2005) a/b ratio, 90° view angle, 5° canting, 15°C
  - 3. …
- Each row of the EM scattering table corresponds to an equivalent melted diameter
- Each column of the EM scattering corresponds to an output:
  - Radar backscattering cross section, σ_b (mm^2)
  - Scattering cross section, σ_s (mm^2)
  - Extinction cross section, σ_e (mm^2)
  - Asymmetry factor, g (dimensionless)
- CStAT does not generate EM scattering tables
  - Find experts already making these complicated calculations
- CStAT creates a library of EM scattering look-up tables
  - Anyone can contribute to this library

Phase II – Develop Modules that Translate Simulated Hydrometeor Distributions into an Integrated Radar Observables

- Uses individual particle EM scattering table to generate integrated radar observations

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Clarification

- The translator is not a radar "simulator"
  - Model resolution is much larger than a radar sample volume
  - "Translator" does not include all radar attributes (e.g., beam width, signal processing)
- The translator is a way to improve communication between observationalists and modelers
- Radar observations have been used to improve models. A translator can help improve observations
  - Models can help determine when radar measurement uncertainties are "good enough"
  - Example: If a model predicts a 1% change in LWC due to aerosol loading, then ARM measurements need to be sensitive enough to detect that change. But radars don't measure LWC, they measure reflectivity and Z-weighted motion. How do we know we have enough sensitivity?

Other Work

- NASA GPM is developing EM scattering tables to ensure that precipitation algorithm developers on different teams use the same EM scattering characteristics