Retrievals and Their Uncertainty: What Every Atmospheric Scientist and Meteorologist Should Know

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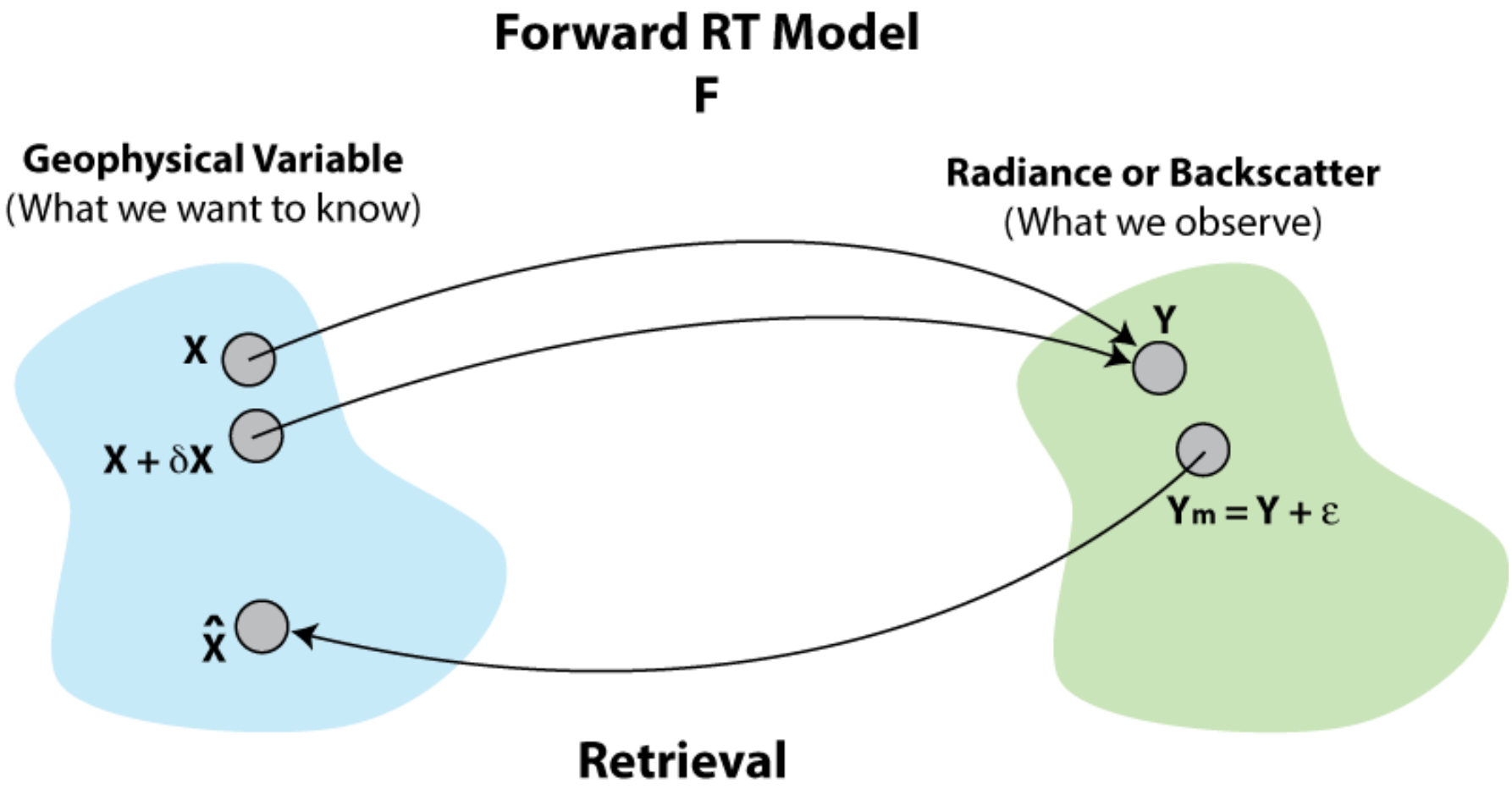
The Retrieval Problem

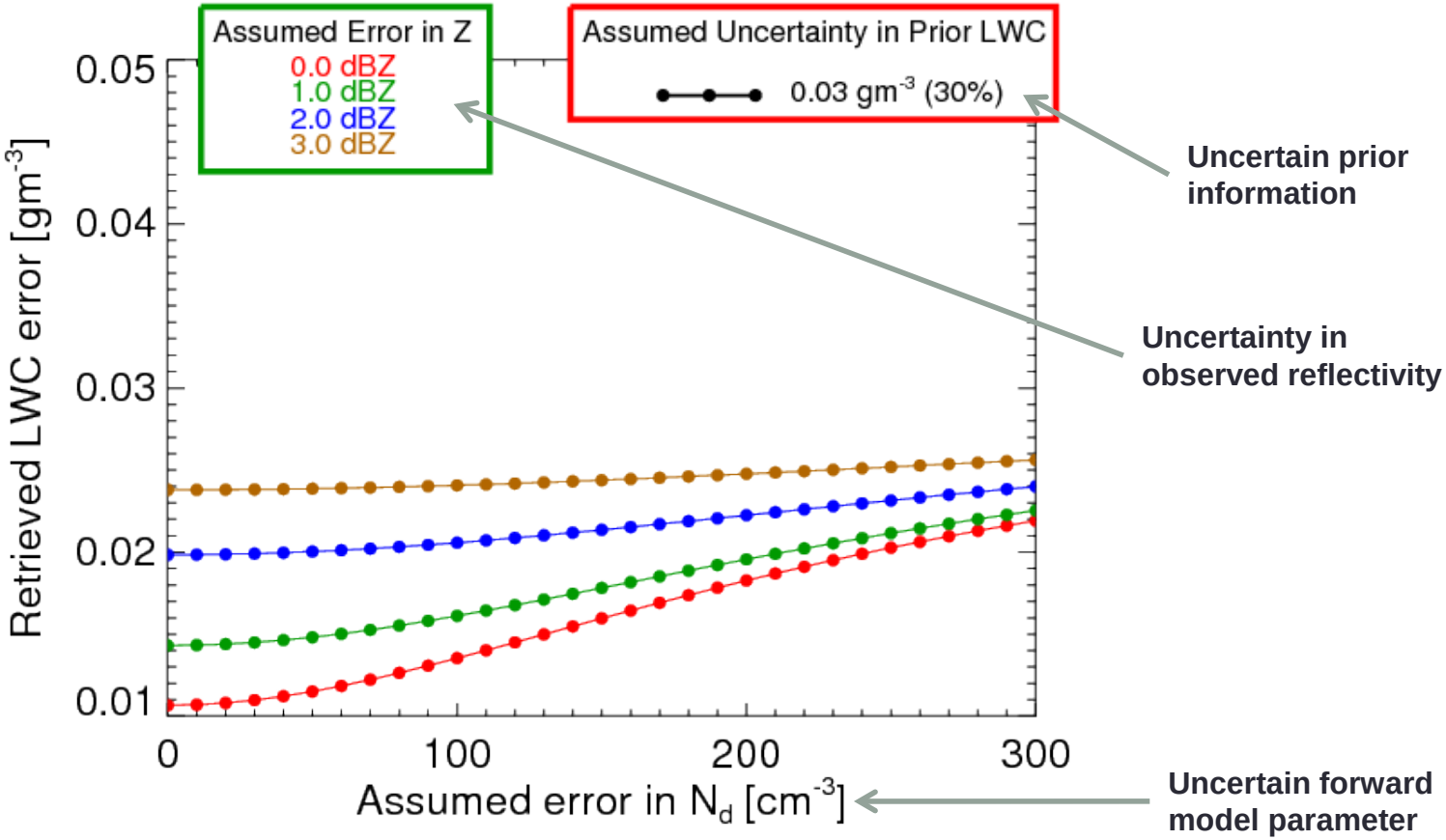


3 Sources of Uncertainty in Every Retrieval

- **Observational uncertainty**
  - Uncorrelated error
  - Correlated error
  - Need to properly characterize instruments
  - Systematic error (e.g., calibration) needs to be treated properly
- **Forward model uncertainty**
  - Uncertain parameters (e.g., size distribution shape)
  - Unknown parameters (e.g., imperfect model)
  - Representativeness and sampling errors
- **Prior dataset uncertainty**
  - Used to develop statistical relationships or serve as constraints
  - Need obs in different climatic regimes and atmospheric conditions
  - If no obs possible, can model sims be used (e.g., LWC profile)?
  - Really need to know correlations btwn variables
  - Often need prior information to constrain forward model parameters

Example: Retrieving LWC from Z

- Retrieve LWC from radar reflectivity (Z)
- Truth: LWC = 0.1 g m^{-3}, N_d = 500 cm^{-3}, Z = -37 dBZ



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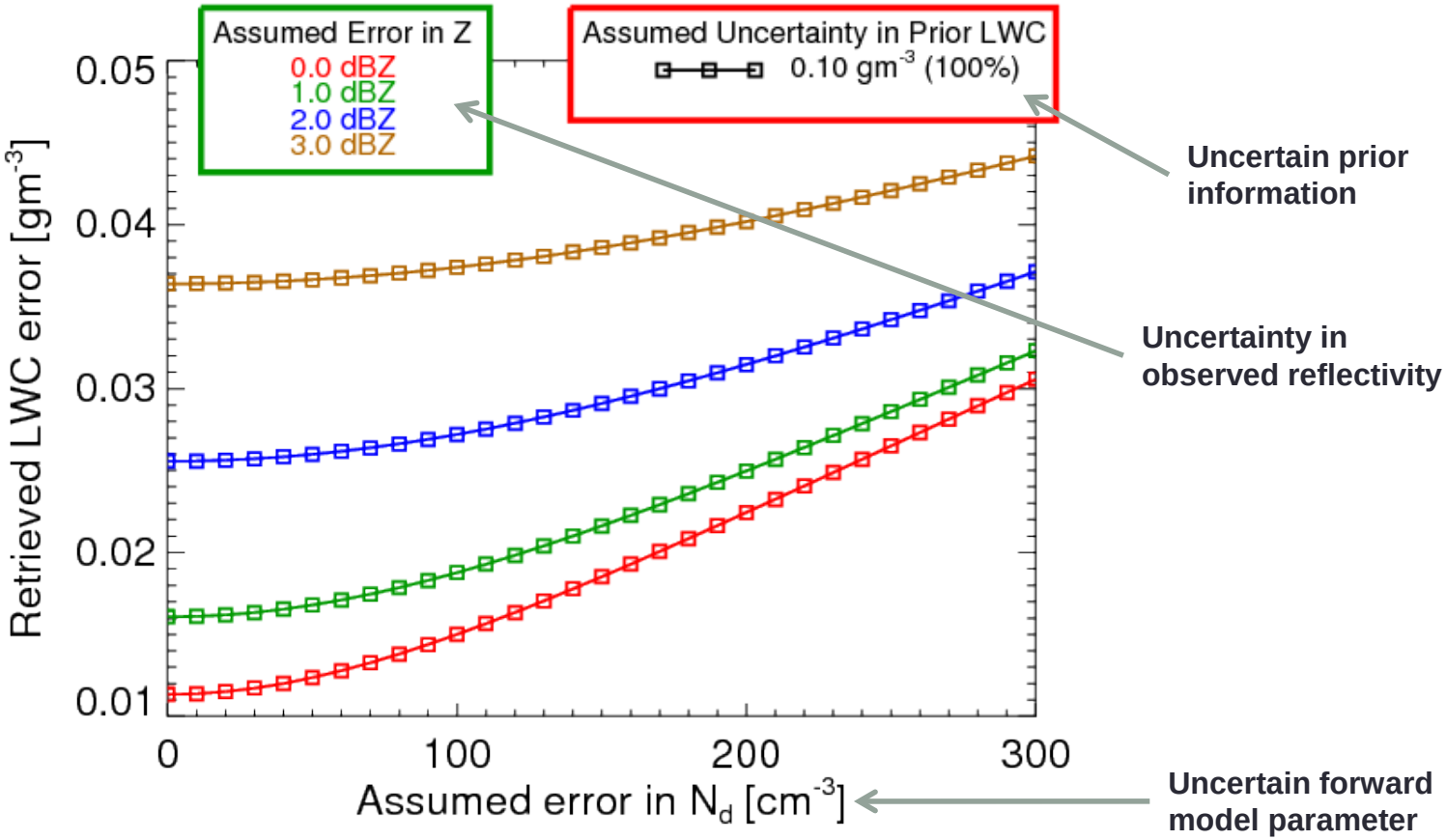

Take Home Messages

- Need to really characterize our instruments
  - Including correlated error
- Forward models need improvement
  - Need better constraints on model parameters
    - May require IOPs aimed to collect this information
  - Closure studies are critical to find inadequacies in forward model
  - Sampling / representativeness errors need to be considered more
- Understand the role of the prior dataset on the retrieval
  - Variational methods allow information content to be evaluated directly, but are more computationally expensive
  - Need to consider how to determine correlations among atmospheric variables when collecting / analyzing these data
  - Need many more additional datasets; prioritize them and collaborate!