Tasks Needed for Lightning Data Assimilation

- Develop and test forward model approaches
- Lightning data input methodology
- Evaluate different assimilation technique

  (e.g., nudging, EnKF, 4D Var)
- NWP model capabilities needed to assimilate lightning

Forward Model Approaches for Lightning Data

- **Equation relating lightning observation to model state parameters**
  - updraft mass flux
  - latent heat
  - liquid water or precipitable water
  - graupel mass flux
  - ice mass flux (maybe start with Petersen et al)
- **Statistical relationships**
- **Single model parameter vs. combinations of parameters**

Lightning Data Input Methodology

Keep model constant and evaluate varying:

- temporal scale of lightning aggregation and influence
- spatial scale of lightning aggregation
- part of lightning used (e.g., CG vs IC, initiation vs extent density)
- lightning data source/resolution (LMA vs LS200 vs WTLN vs GLM)

NWP Model Capabilities Needed to Assimilate Lightning Data

- Improve microphysical packages (e.g., better ice treatments)
- Determine grid resolution needed for updraft, microphysics, and lightning
- Need to include electrification mechanisms for more direct lightning data assimilation

Forecast the Lightning Hazard

- Include total lightning in perfect prog (i.e., develop total lightning input and output)
- Incorporate lightning rate output in NWP
  - Extensively test McCaul algorithm
  - Develop estimates from model microphysics

Develop Lightning Flash Rate Density Climatology (i.e., not just density distribution, but storm flash rates)

- For model and forecast verification
- For a characterization of abnormal threat
- For use in developing statistical assimilation
- A natural byproduct of 2-σ algorithm test