A Roadmap for a Lightning Modeling Grand Challenge

GLM Science Meeting
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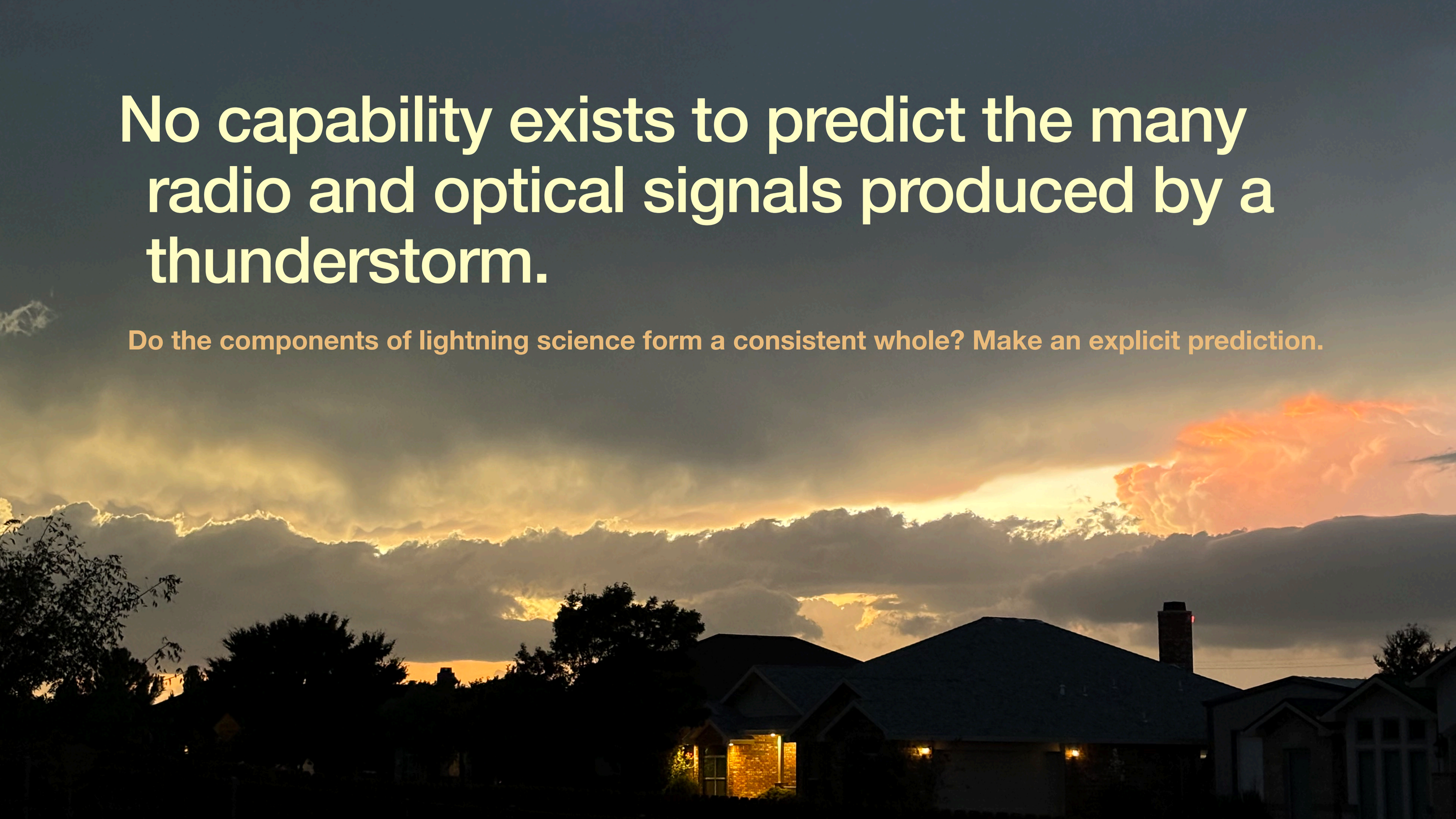
Thanks to the Lightning Modeling Panel
for their work on the roadmap:
Amanda Back, NOAA Global Systems Laboratory
Sonja Behnke, Los Alamos National Lab
Steve Goodman, Thunderbolt Global Analytics

Thanks to Sandia National Laboratory for instigating and supporting the initial draft of the roadmap

Chris Hogg, Sandia National Laboratory
Timothy Lang, NASA Marshall
Julia Tilles, Sandia National Laboratory



No capability exists to predict the many radio and optical signals produced by a thunderstorm.

Do the components of lightning science form a consistent whole? Make an explicit prediction.

Why a lightning model?
Some Stakeholders (USA)

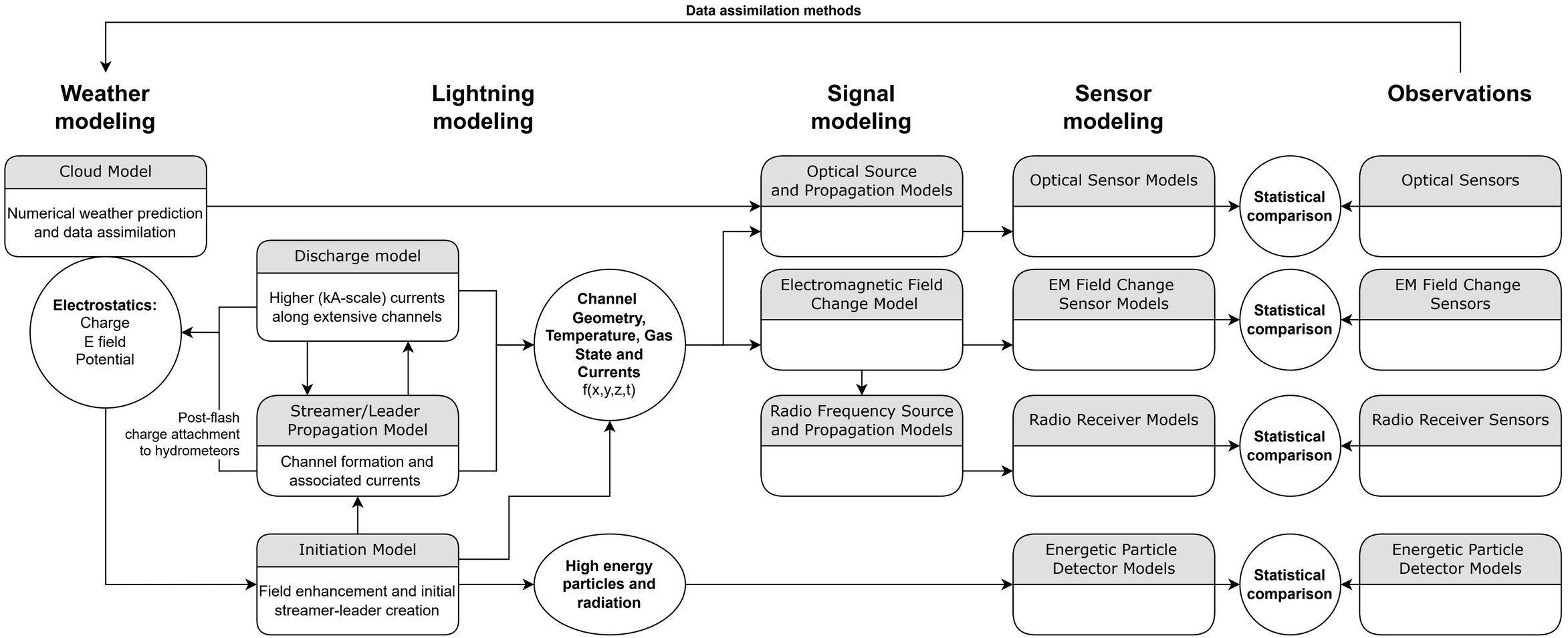
- **NSF:** basic science of lightning
  - Lightning physics, meteorology of electrification
- **NASA/NOAA:** optical lightning sensors and climate-scale observations
  - Need for physics-based observing system simulation experiments
- **NOAA:** Explicit forward modeling of lightning for Numerical Weather Prediction
  - Data assimilation of varied lightning sensor types, hazard modeling
- **DOE:** Earth-observing platforms and sensors
  - Lightning a near-constant background signal

Writing the roadmap

http://lightning.ttu.edu/workshop

- Formed **lightning advisory panel** to organize an initial workshop
- **Held 60-person workshop** with a day of invited talks and a day of breakouts
  - Identified requirements, gaps, and recommendations.
  - Strong consensus that computing, observations, and knowledge are mature enough to try integration
  - No need to reinvent — focus on stitching together existing models and comparing to observations
- **Visited** with NSF, NASA, NOAA, DOE, etc. to build awareness of the roadmap effort
- **Initial draft** of a 5-year roadmap is complete, about 30 pages in length
  - **Practically-focused**: what exists, how can we stitch it together?
  - *Inputs, outputs, uncertainties, evaluation methods, next steps*

Major model components

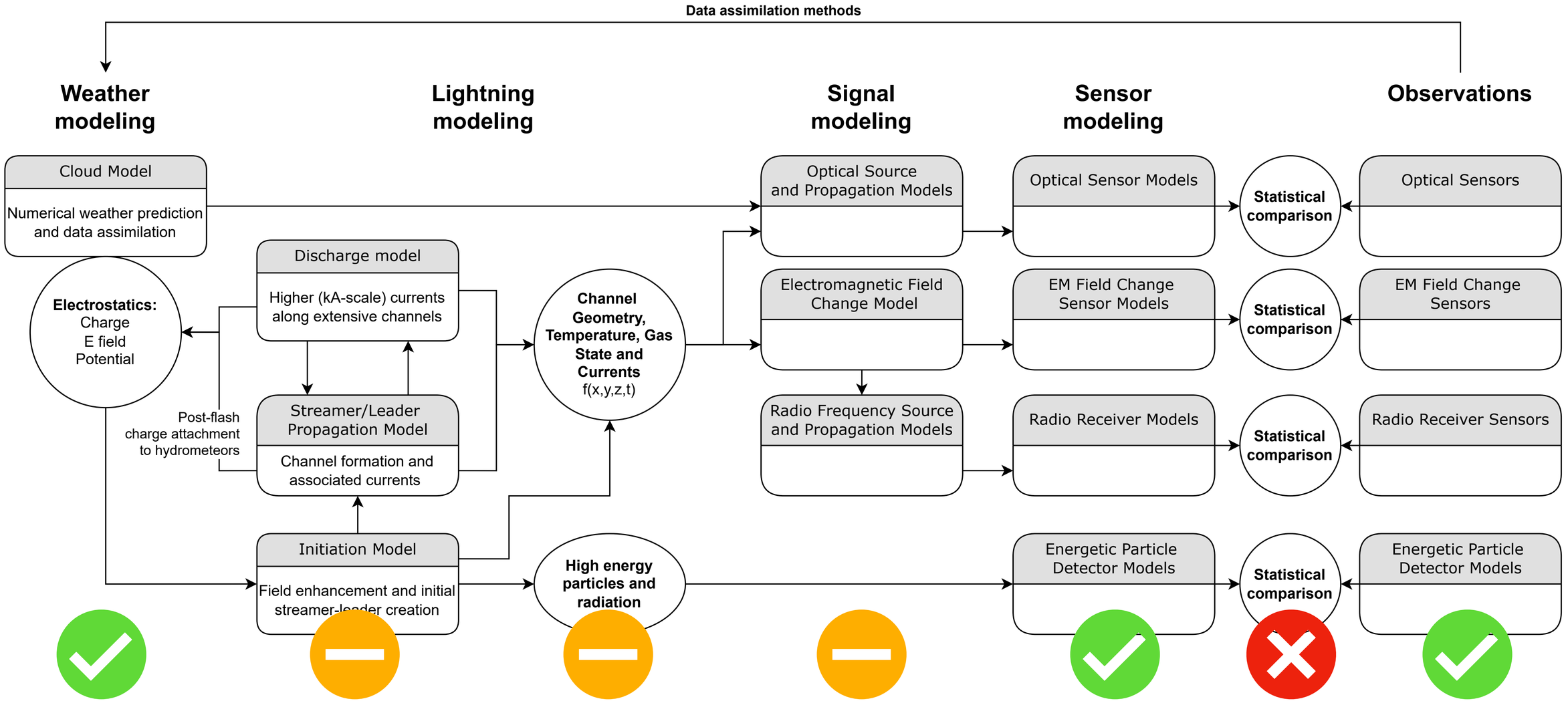


Loose coupling between components is preferred where possible.

Ancillary models for chemistry, impacts to human and natural environments, etc. are envisioned.

Qualitative Readiness

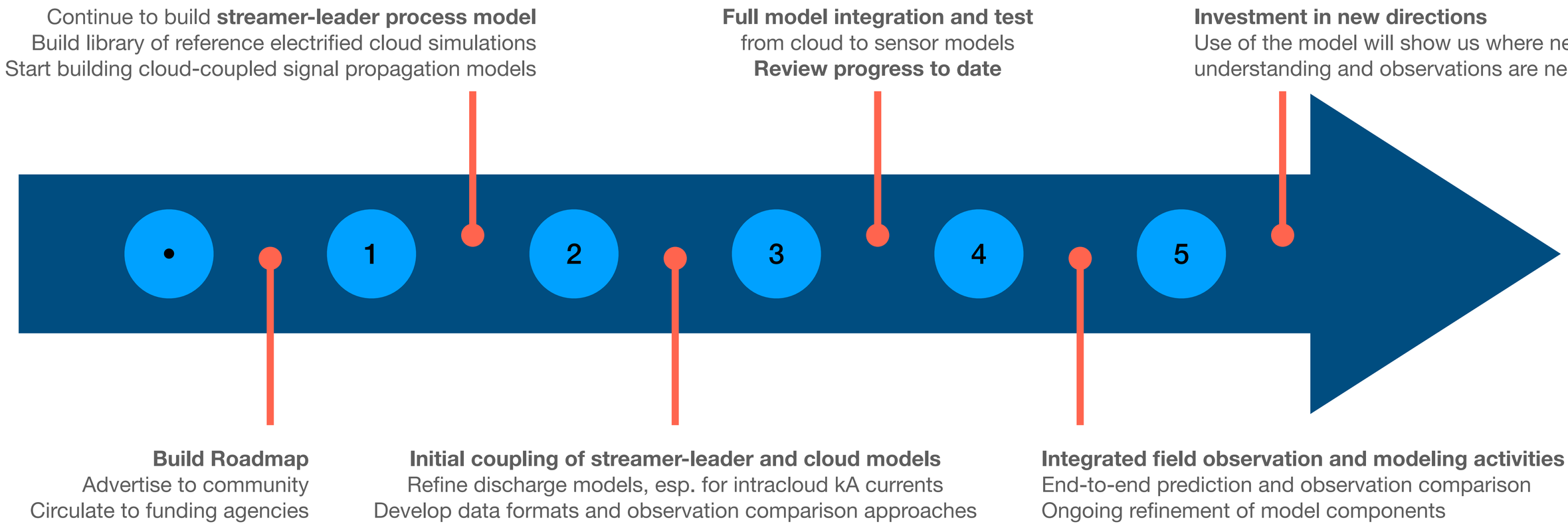
≠ **perfect**, but is mature enough for use in an initial end-to-end prediction



Lightning science is **fragmented and observation-driven** to date. Not possible to make a holistic model-observation comparison.
Smaller model-theory-observation loops test some sub-processes, but **need connections** and **full-storm-scale physics**.

Timeline

For the next five years



Implementation will follow a community-governed open source model.

Community Input

Upcoming events

- Roadmap draft out for review to invited speakers, and available later this fall
- Town Hall Meetings
  - AGU (December 2024)
  - AMS (January 2025)
- Next Workshop
  - 1-3 April 2025, Texas Tech University
- Goals: discuss, refine, and review progress on the roadmap

Workshop invited speakers

- Joe Dwyer, University of New Hampshire
- Ted Mansell, NOAA National Severe Storms Laboratory
- Amitabh Nag, Los Alamos National Laboratory
- Caitano da Silva, New Mexico Tech
- Patrick Gatlin, NASA Marshall Space Flight Center
- Matthew Hopkins, Sandia National Laboratory
- Patrick McFarland, Penn State University
- Kristen Rasmussen, Colorado State University
- Xuan-Min Shao, Los Alamos National Laboratory
- Scott Wolff, United States Air Force