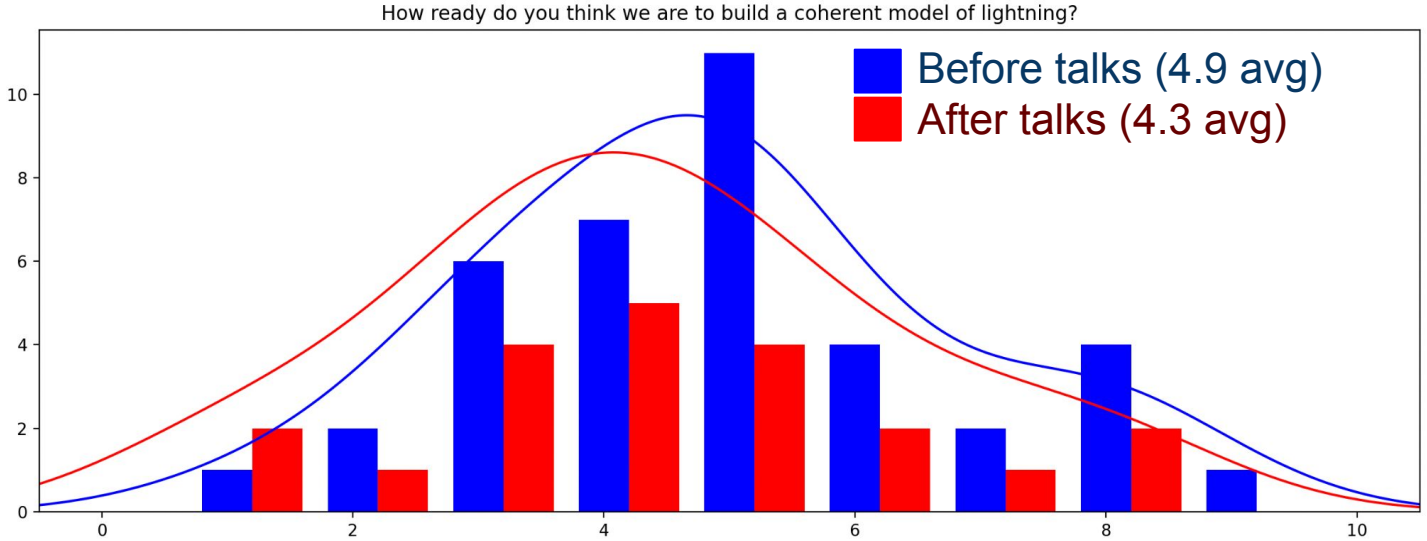
Survey and sticky note feedback

Lightning modeling workshop

Survey results (1/2)

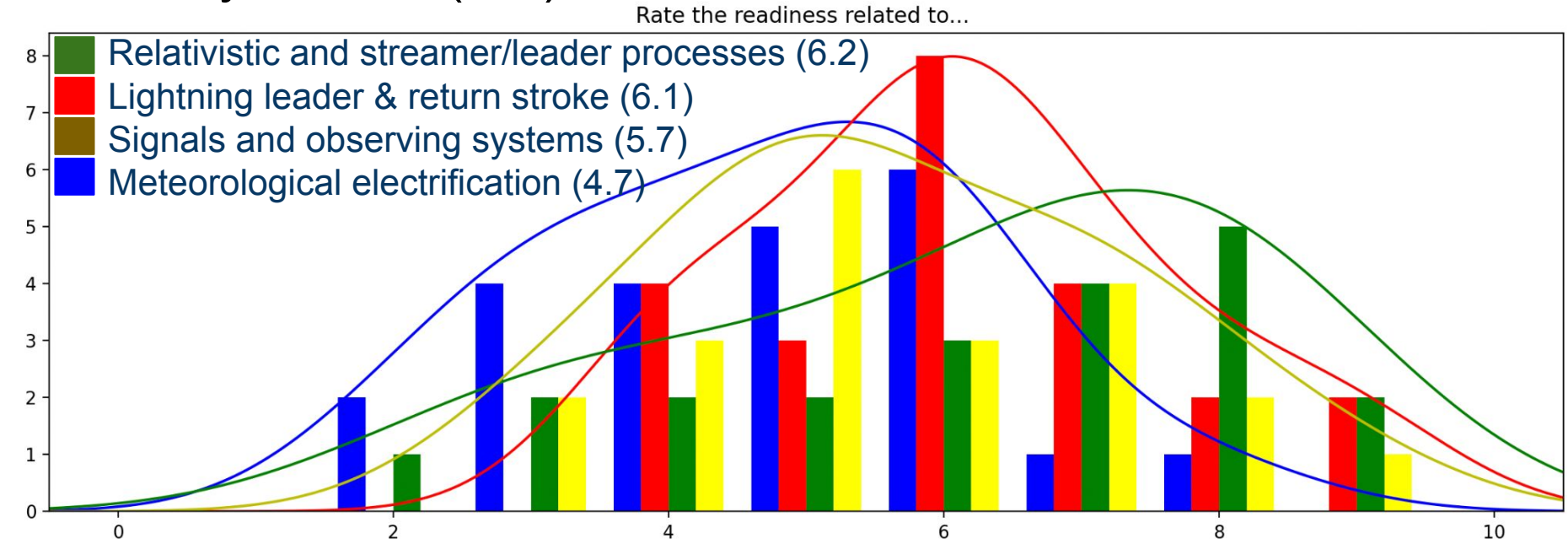


38 respondents before talks

21 respondents after talks

No 0’s or 10’s; increase in 1’s despite smaller sample size after talks

Survey results (2/2)



21-23 responses to all questions

No 0's, 1's or 10's

No one rated lightning leader and return stroke <4

Relativistic and streamer-leader processes had most high ratings (7-9)

What are our modeling strengths?

- **Availability of quality datasets** for validation
- **Better availability of HPC** compared to any time in history
- **Multiple disciplines needing capabilities** (e.g., laser people looking at high-res monte carlo atmos/cloud modeling too)

Domain science knowledge was not mentioned

Where do we need more knowledge? (1/3)

- Need **high position resolution (100m) profiles of cloud field**
- Need **hydrometeor identification simultaneous with charge measurement**
- Need **high time resolution E-field measurements** (10-100 milliseconds)

Need better observations of some processes

Where do we need more knowledge? (2/3)

- **Microphysics vs particle charging:**
  - Which is further developed or understood: particle microphysics or the charge on said particles? (For predicting onset & type of lightning)
  - How accurate does the particle microphysics need to be vs the electrical charge on those particles- what do the models predict reasonably well or poorly, say Partition of flash rate, flash type, Flash extent, flash energy…
- **Electrification impact on microphysics**:
  - Fully coupled microphysics and electrification (electrodynamic feedback on microphysics)
  - How much do we even know about the full feedback of electrification on cloud microphysics?
- Need **better theoretical understanding of charge separation mechanisms**

Microphysics and electrification uncertainties

Where do we need more knowledge? (3/3)

- **Variations in spectral emissions** wrt discharge type / intensity
- Streamer production and discharge path lead to current flow and ohmic heating with subsequent optical emission. **What is the connection between the branch formation and the flow**.
- **Interconnection between** different constituent **models.**

Emissions; branching and current; how model components will couple

What are your concerns? (1/2)

- **The lightning model scope** as discussed ends when light (or RF) is produced. But **does not include when light stops being produced.**
- We **lack knowledge about charge distribution** in actual cloud structures, which makes **verification difficult**.
- Current state is not showing **temporal and spatial consistency between model**ed system **and** physical **observations**

Lacking knowledge;
stated scope overlooks some aspects

What are your concerns? (2/2)

- Mutual **understanding between diverse multidisciplinary scientists**. Balancing resources.
- **Coordinating diverse validation datasets** which can be used for each component from the environment to the storm evolution and microphysics to electrification to breakdown to impacts to lightning observations.
- **Coordinating output from one segment**/model step **with input of the next model segment**/step.

Coordination and collaboration

Your realistic, candid expectations for the model:

- I expect a model to **produce results of complex processes** and depict those **in a digestible format**
- **Generate source terms, propagate** through cloud / atmosphere / ionosphere, **receive at** ground/air/space **sensor**
- **Mimicking a sensor** (e.g., GLM) is one way to validate model results, but **is limited by the sensor**. Thus the model is limited by sensors, what we can observed about lightning. **This is really an incomplete picture.**
- It seems that **Caitano's model could be coupled to Ted's model**- how might that be done, what are the gaps?

Do model-y stuff
Model of only observables is incomplete

Tuesday additions:

- **Modeling strength**: We have a number of existing models that collectively can successfully simulate many aspects of the lightning problem. So the main work needed is to stitch them together, rather than reinventing the existing core modeling capabilities.
- **Need knowledge**: This may be a personal ignorance question: Do hydrometeor types/concentrations impact leader development?
- **Need knowledge**: The physics at leader tips that determines speed and propagation direction. (For all leader types.)
- **Concern**: Some aspects of lightning seem to be fundamentally stochastic, even for an accurate model the variety of physically possible outcomes may be difficult to combine into a meaningful overall picture.