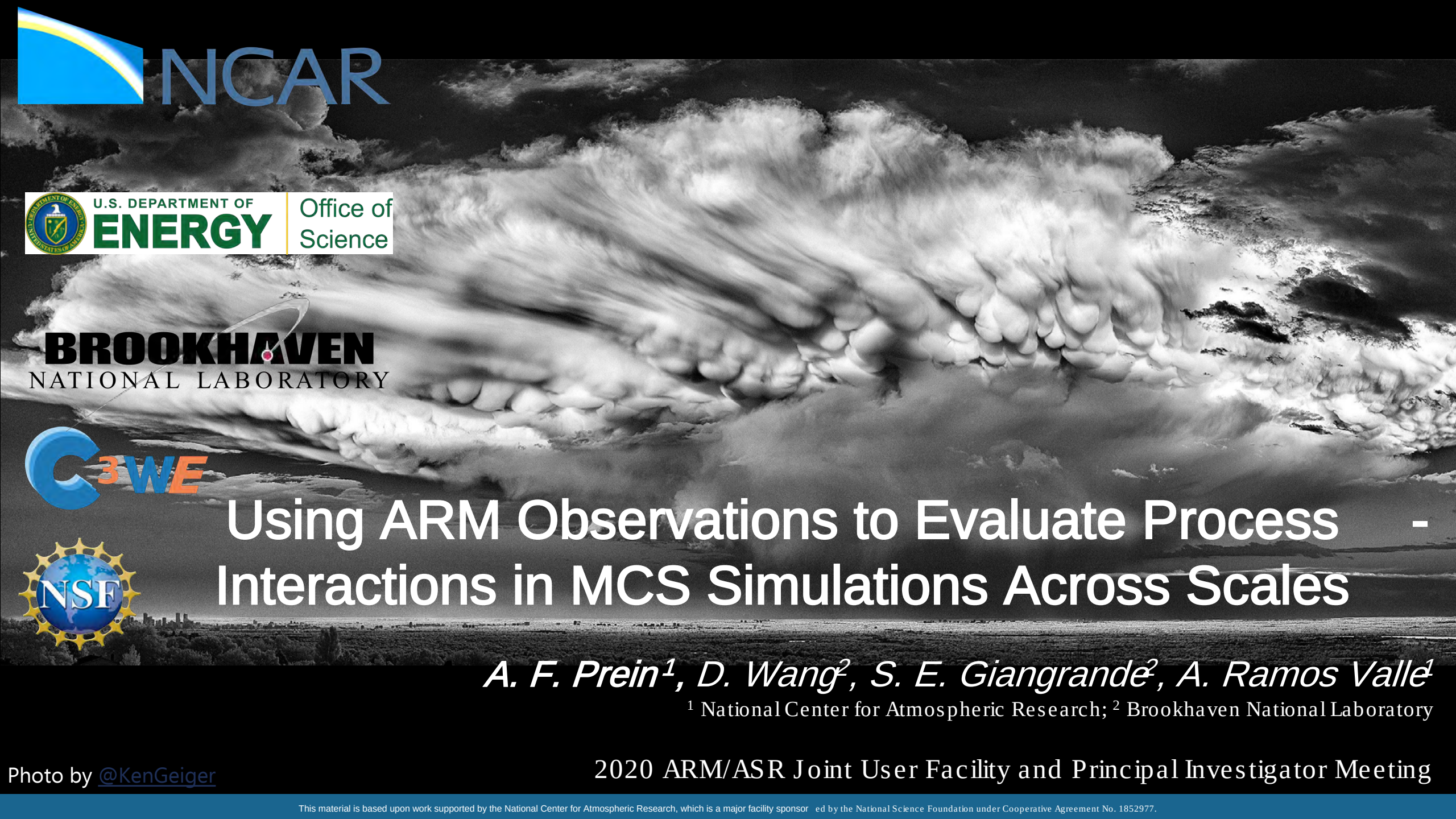

Using ARM Observations to Evaluate Process - Interactions in MCS Simulations Across Scales

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Photo by @KenGeiger

2020 ARM/ASR Joint User Facility and Principal Investigator Meeting

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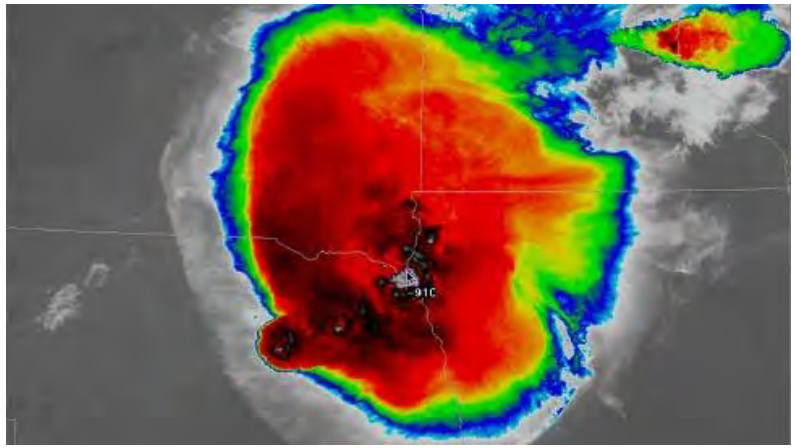
What is a Mesoscale Convective System (MCS)?

MCSs take on a variety of forms

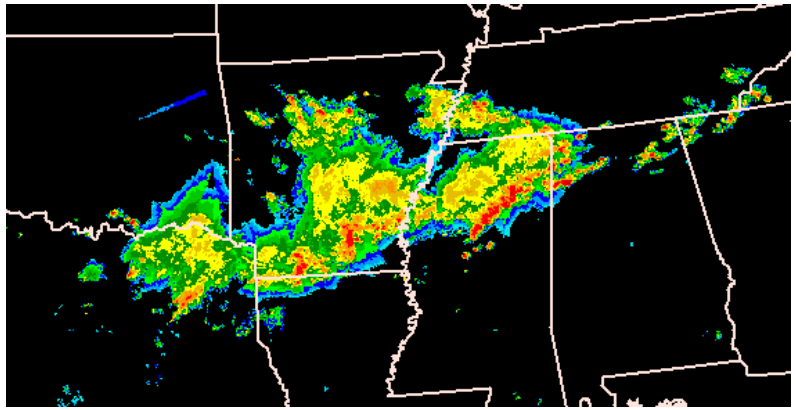
- Organized
- Large
- Convective
- Long-Lived

- " …a cumulonimbus cloud system that produces a contiguous precipitation area100 km or more in at least one direction." [Houze 2004]

Satellite IR



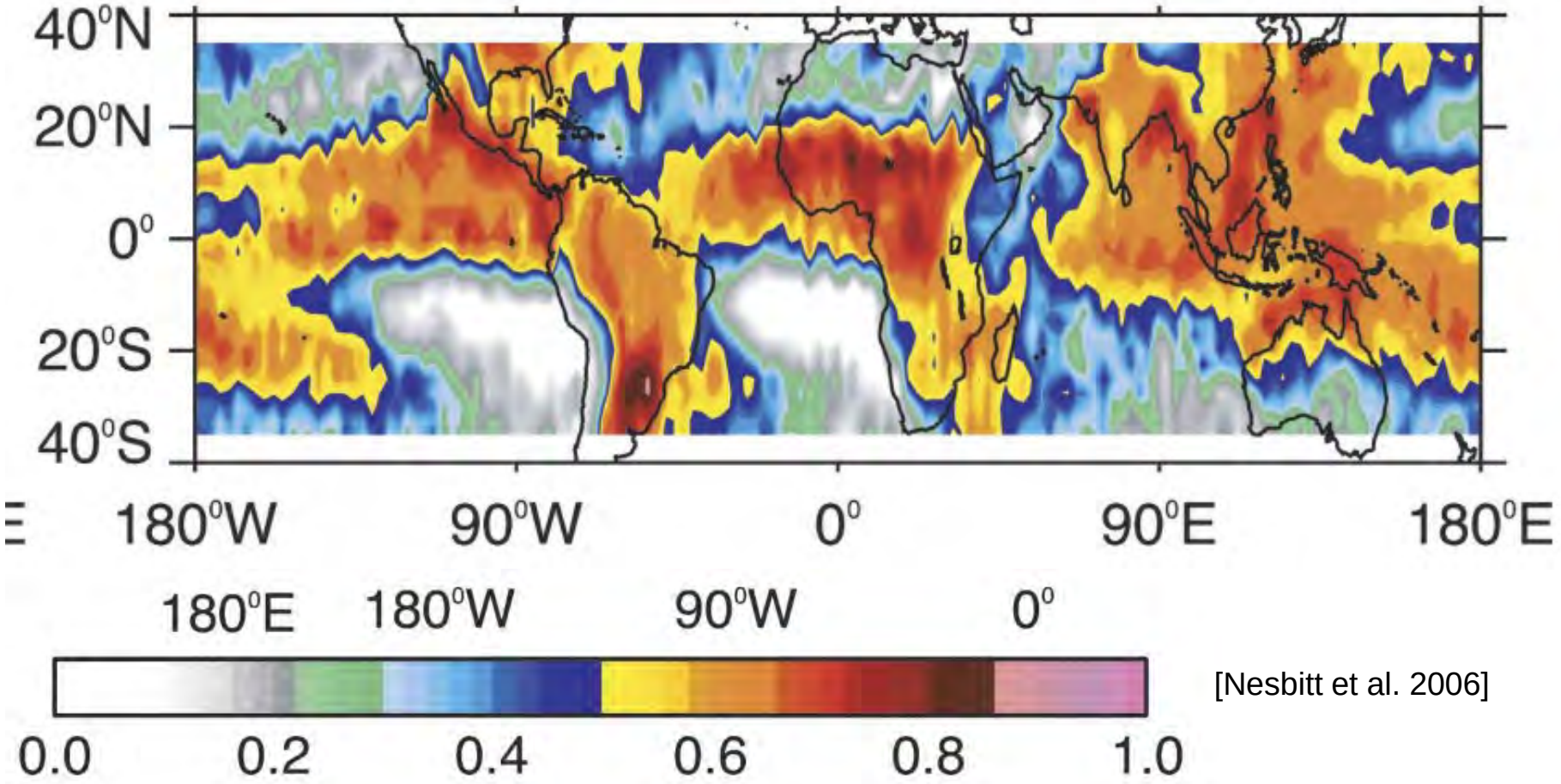
Radar Reflectivity



Why are MCSs Important

MCS contribute more than 50 % or rainfall in most of the tropics and parts of the mid latitude

Fraction of Rainfall from MCSs



[Nesbitt et al. 2006]

Aims

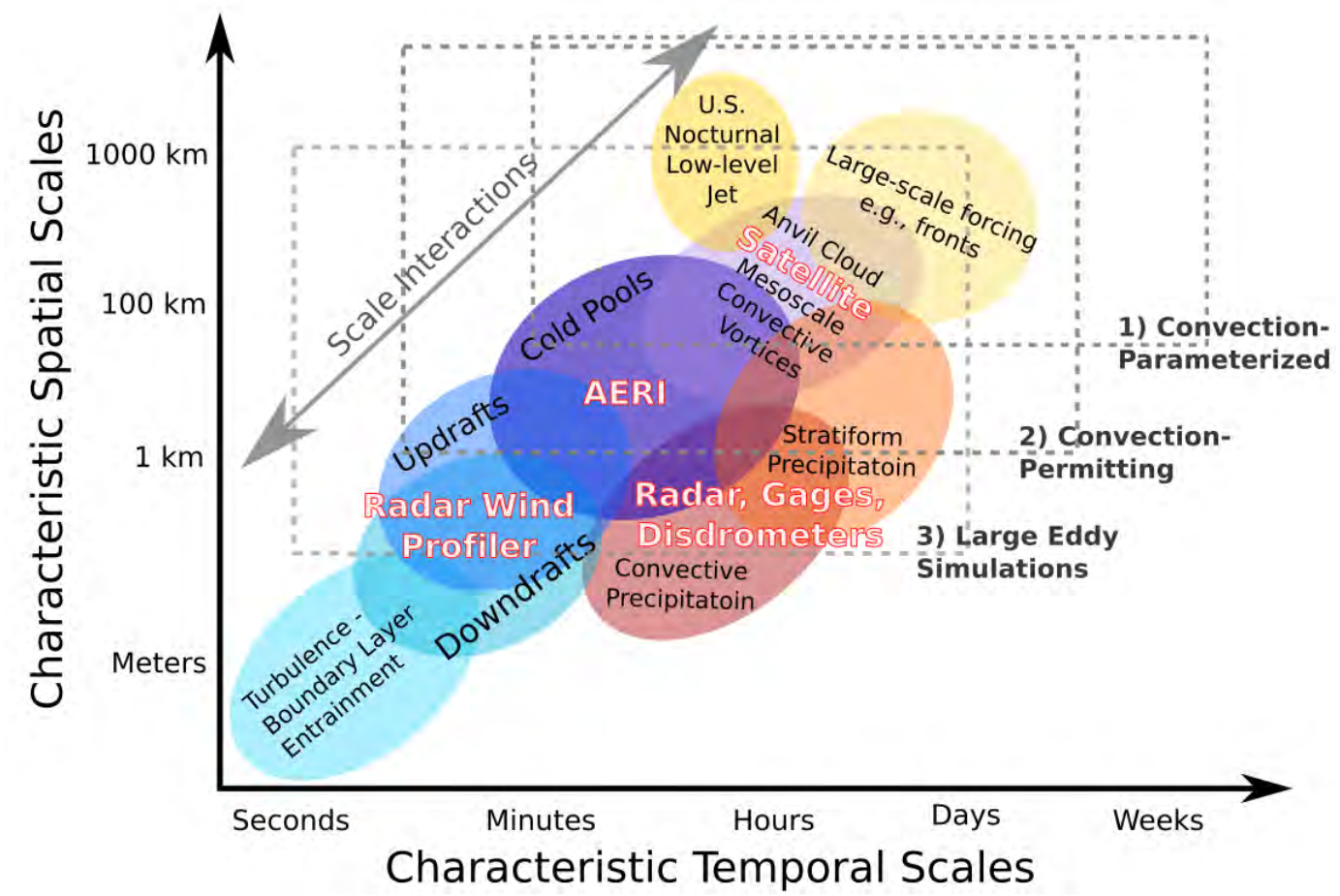
1. Use DOE ARM observations to constrain ensemble of simulated MCSs in different environments

2. Evaluate MCS process representation in state-of-the-art models

Goal

- Improved process-level understanding of MCS characteristics targeted at more effective MCS simulation capabilities in climate models

Complex Process Interactions Across Multiple Orders of Magnitude



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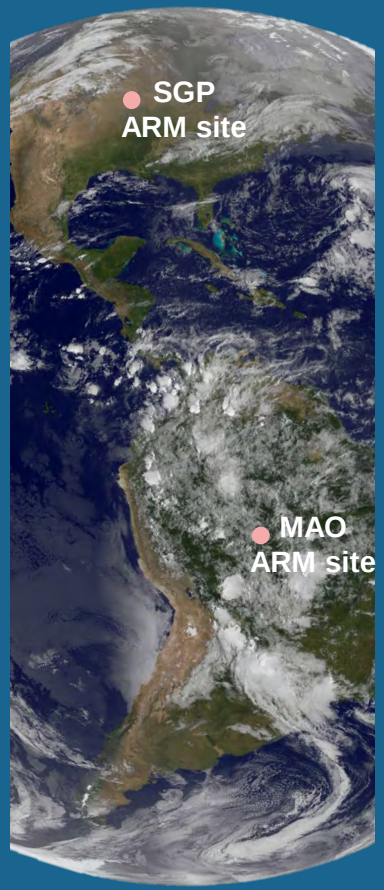
Observational and Model Datasets

Observations



MCS cases

- SGP - 16 MCSs
- MAO - 45 MCSs

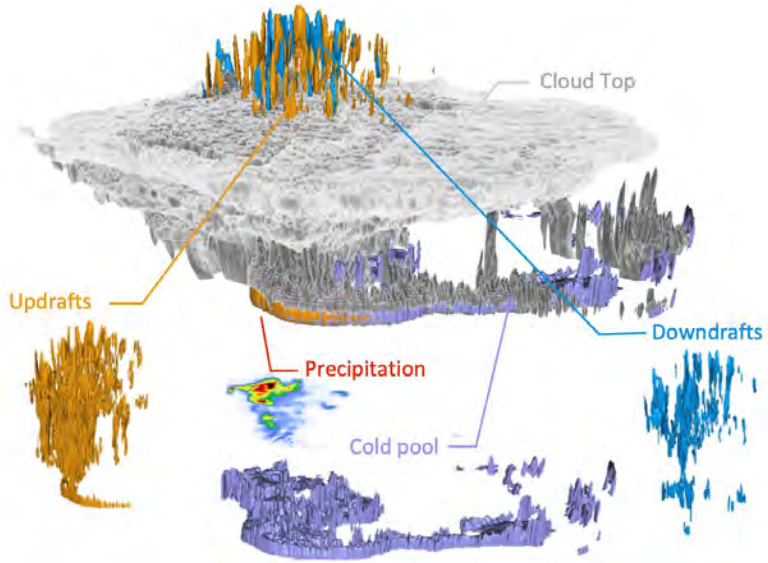
Key observations

- Pre-MCS soundings
- Radar Wind Profiler
- Disdrometer observations
- Radar observations
- Interferometer data
- Satellite observations

Modeling

Weather Forecast and Research (WRF) model

- Δx from 12 km to 125 m
- Idealized and real case simulations
- Microphysics sensitivities
- 5-min instantaneous output and model time step output for single columns



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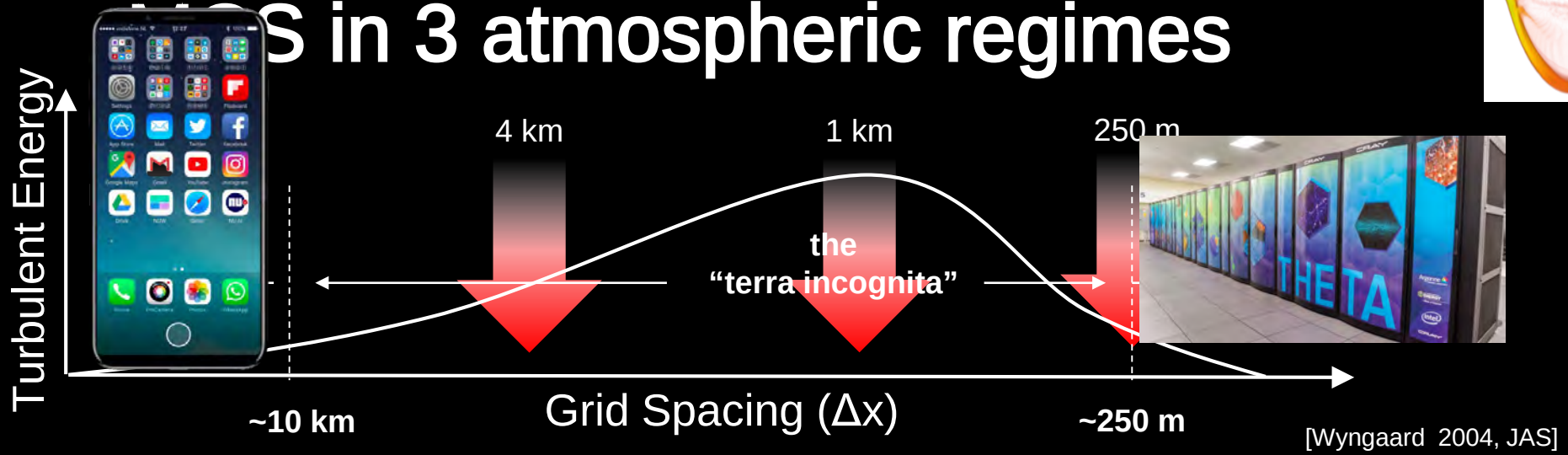
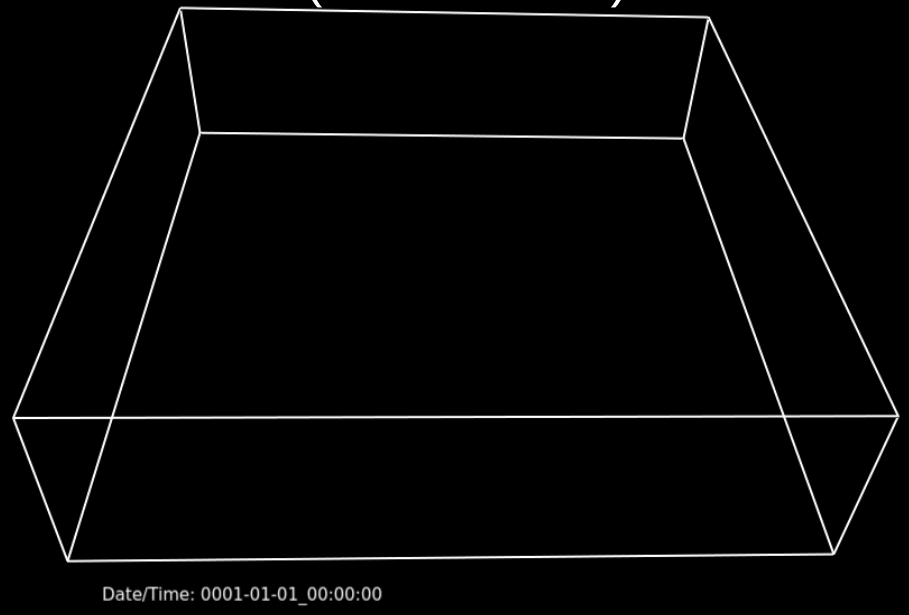
MPAS in 3 atmospheric regimes

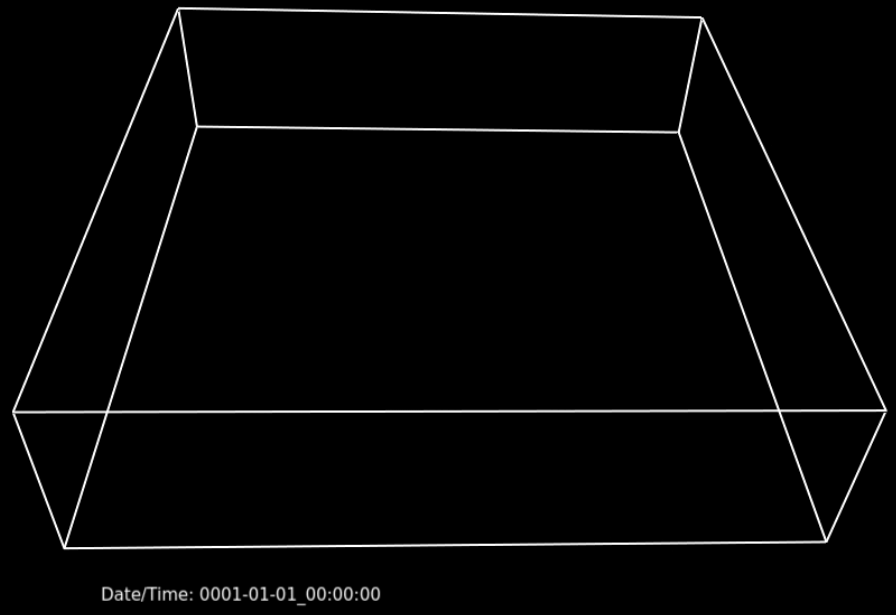


[Wyngaard 2004, JAS]

Δx = 12 km
(K-F scheme)



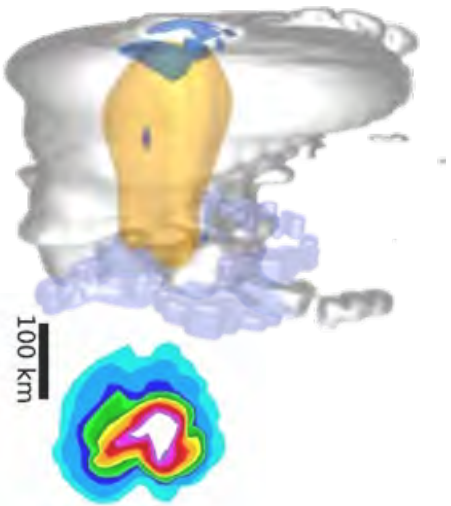
Δx = 4 km



Prein et al. 2020

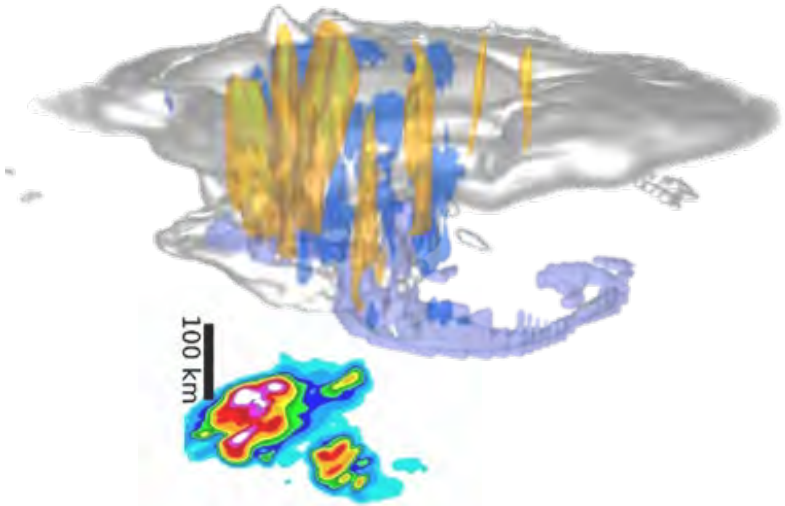
Δx Sensitivity of Idealized MCSs

Δx=12 km



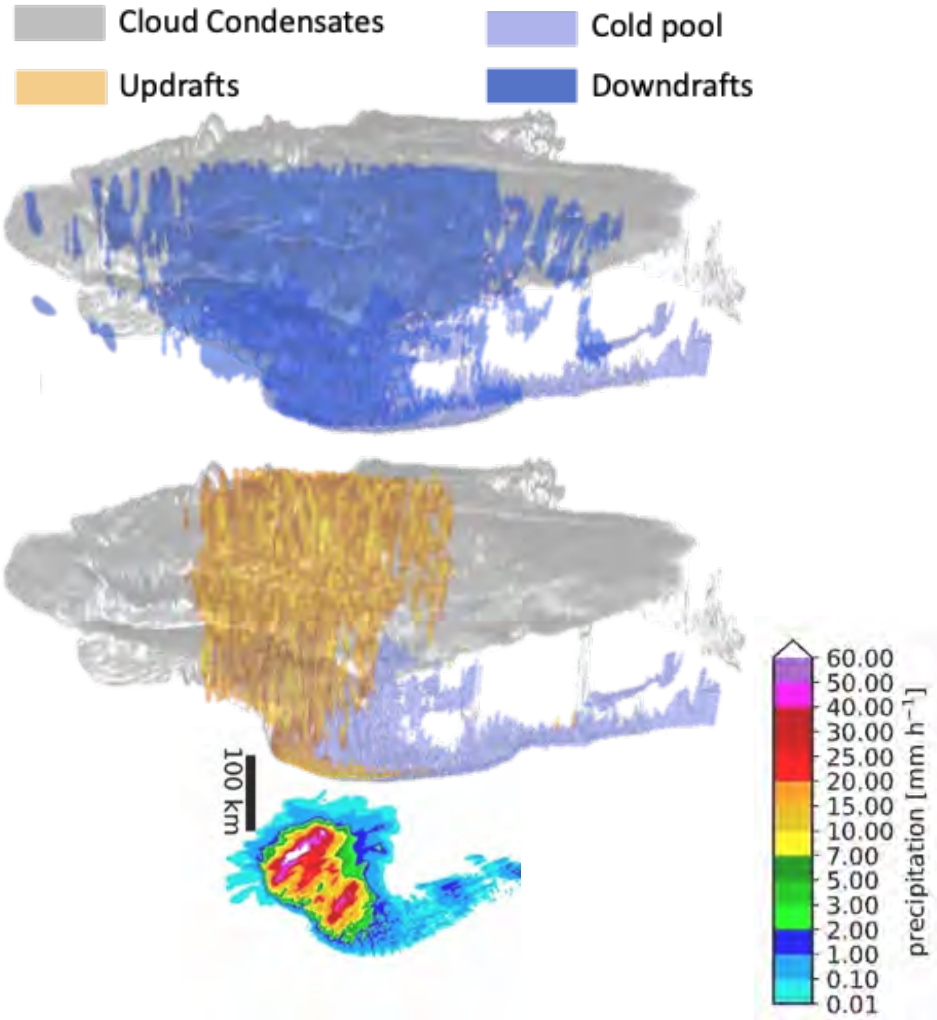
- Too weak and localized peak precipitation
- 20 % too weak coldpools
- Single extremely wide draft
- Anvil is too small and too low

Δx=4 km



- Too intense peak precipitation
- 5 % too weak coldpools
- To wide, deep, and intense drafts
- Anvil has similar extent but is too high

Δx=250 m



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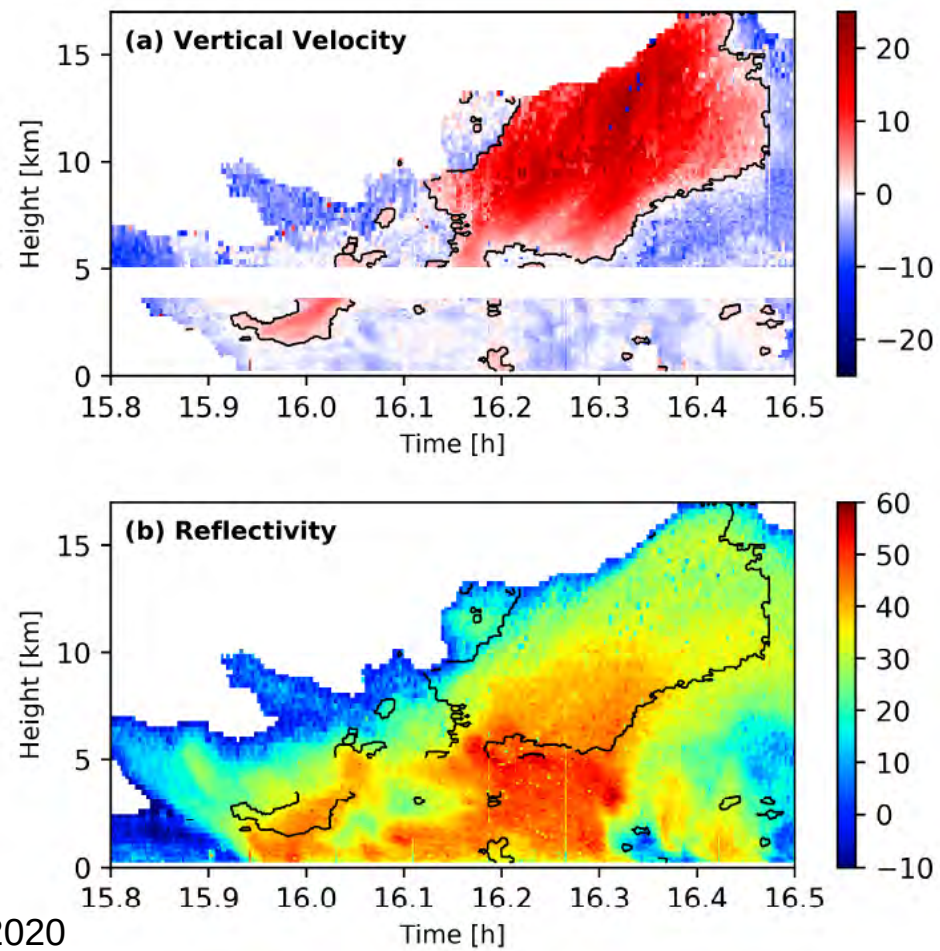
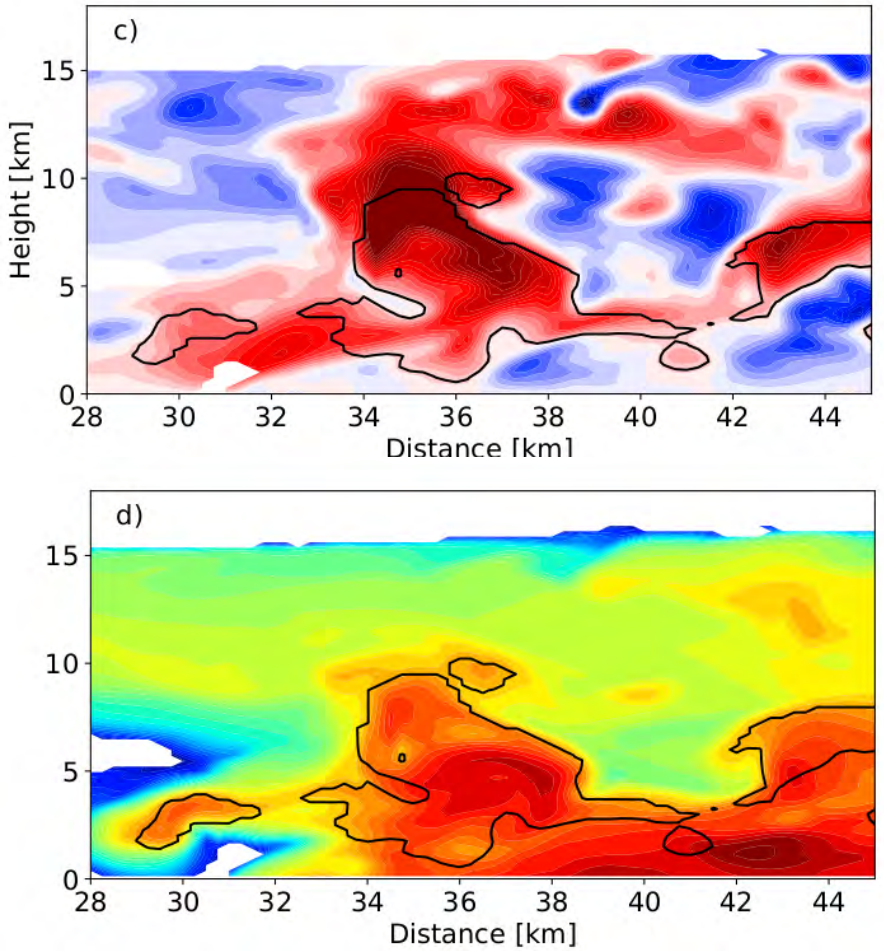
Observed VS. Modeled Draft Properties

Radar Wind Profiler MCS Overpass

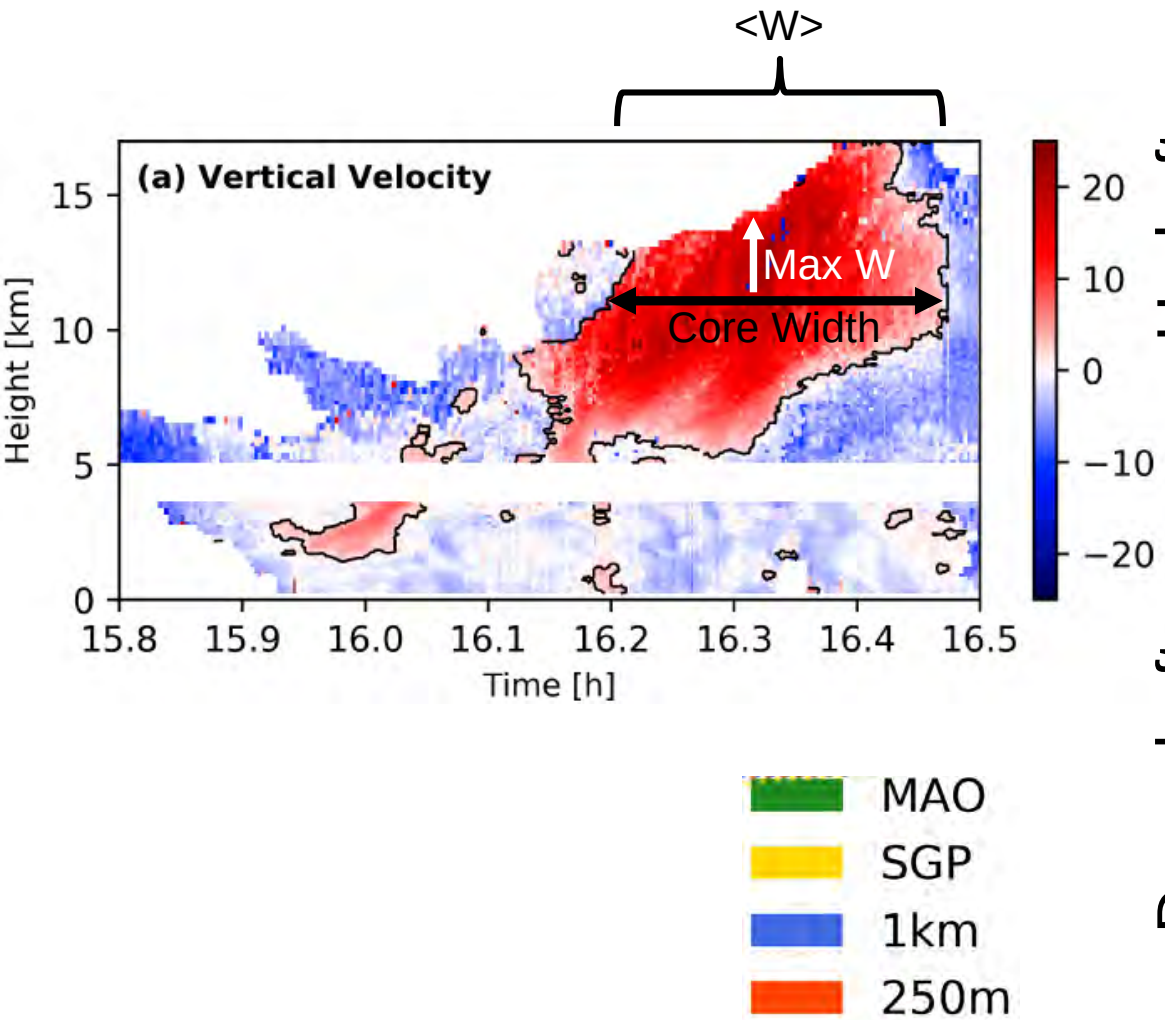


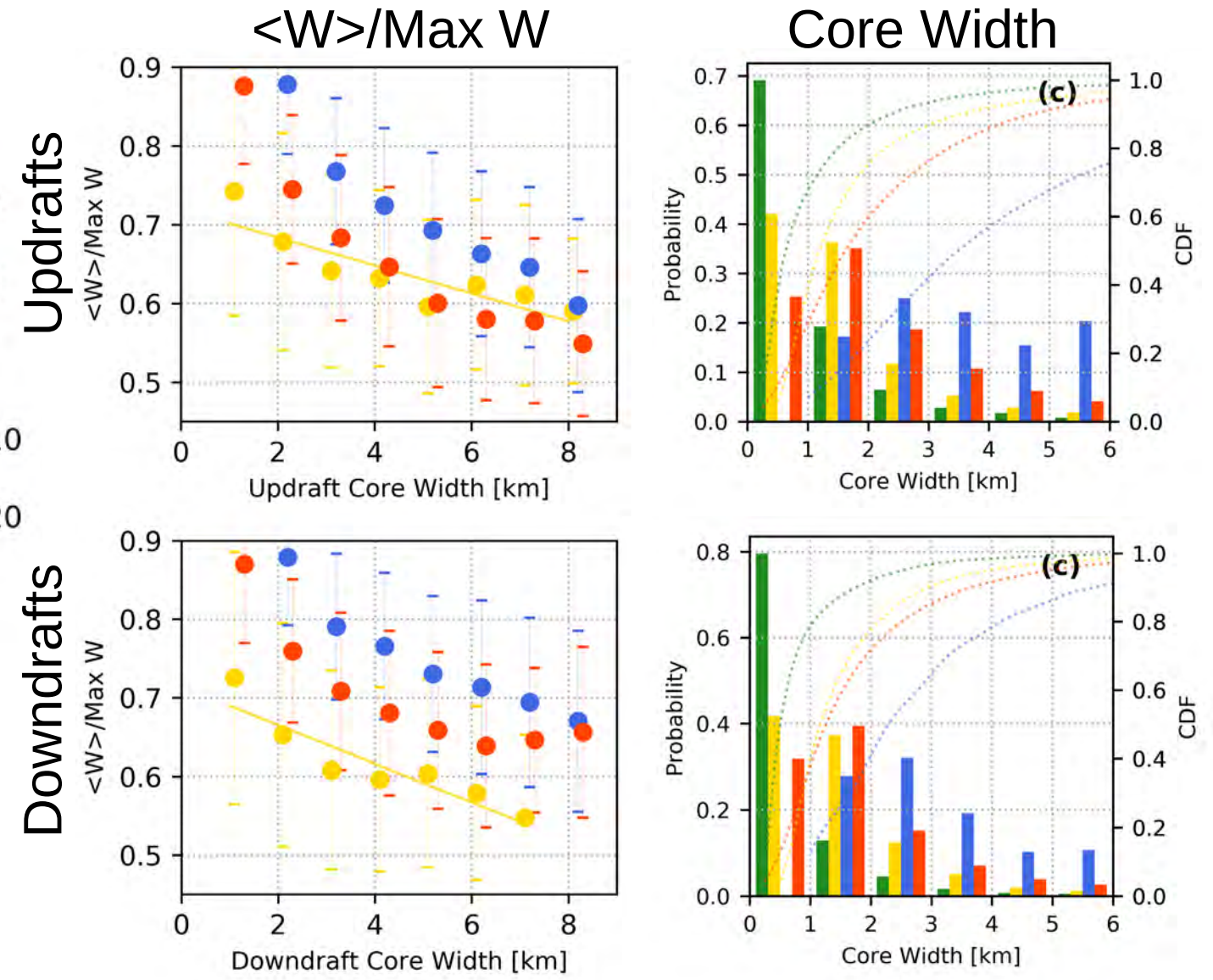
Δx=250 m WRM Idealized MCS



Wang et al. 2020

Comparing Observed and Modeled Drafts





Wang et al. 2020, JGR

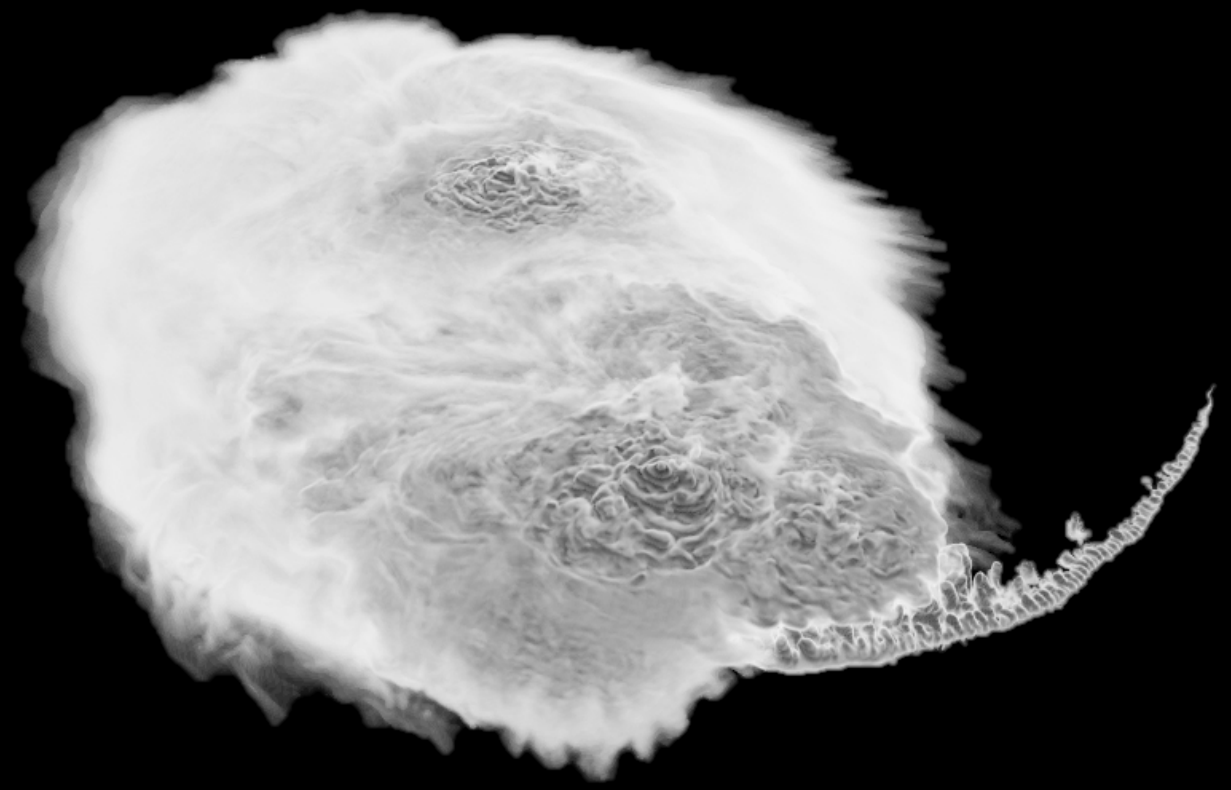
Summary & Conclusion

- Observational and model data will be generated to improve process-level understanding of MCS characteristics in mid-latitude and tropical environments

- Goal is to develop more effective and reliable MCS simulation capabilities in weather and climate models

- Encouraging initial results – LES scale simulations similar to ARM observations

- Let us know if you are interested in using the produced dataset
  - Deep convective anvil clouds
    PI: Gregory Elsaesser
  - Testing remote sensing retrievals
    Shen et al. (2020)



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