

# Impact of Global Warming on U.S. Summertime Mesoscale Convective Systems: A Simple Lagrangian Parcel Model Perspective



Qiu Yang, Ruby Leung, Zhe Feng, Xingchao Chen Pacific Northwest National Laboratory (PNNL) 20<sup>th</sup> Conference on Mesoscale Process July 17<sup>th</sup>, 2023, Madison, WI OBS: fraction of MCS precipitation



MCSs are the major rain producer

Prein et. al., (2020) in Clim. Dyn.

MCS Track density difference (WRF – OBS)

## Building a Lagrangian parcel model for MCSs



Yang, Q., Leung, L. R., Feng, Z., Song, F., and Chen, X. (2021): A Simple Lagrangian Parcel Model for the Initiation of Summertime Mesoscale Convective Systems over the Central United States, Journal of the Atmospheric Sciences

#### Capturing early-afternoon peak of convection



Yang, Q., Leung, L. R., Feng, Z., Song, F., and Chen, X. (2021): A Simple Lagrangian Parcel Model for the Initiation of Summertime Mesoscale Convective Systems over the Central United States, Journal of the Atmospheric Sciences



Yang, Q., Leung, L. R., Feng, Z., and Chen, X. (2022): Impact of Global Warming on U.S. Summertime Mesoscale Convective Systems: A Simple Lagrangian Parcel Model Perspective, Journal of Climate

### Changes in convective population under warming





Consistent with Rasmussen et. al. (2017) using high-resolution convection permitting regional simulations

Yang, Q., Leung, L. R., Feng, Z., and Chen, X. (2022): Impact of Global Warming on U.S. Summertime Mesoscale Convective Systems: A Simple Lagrangian Parcel Model Perspective, Journal of Climate

## Capturing upscale growth feature during MCS genesis



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- ✓ Single-column model predicts mean precipitation decrease over the central U.S.
- Single-column model predicts a decrease in weak and moderate precipitating events, but an increase in strong ones
- ✓ Multi-column model predicts an MCS size decrease under warming, but it can still increase under favorable conditions
- Yang, Q., Leung, L. R., Feng, Z., and Chen, X. (2022): *Impact of Global Warming on U.S. Summertime Mesoscale Convective Systems: A Simple Lagrangian Parcel Model Perspective*, Journal of Climate
- Yang, Q., Leung, L. R., Feng, Z., Song, F., and Chen, X. (2021): A Simple Lagrangian Parcel Model for the Initiation of Summertime Mesoscale Convective Systems over the Central United States, Journal of the Atmospheric Sciences



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(h) Future precipitation change

Future precipitation change (CMIP5.mm/day



