Climate Team Overview and Progress

Jonathan Winter, Brian Beckage, Patrick Clemins, Janel Hanrahan, Maike Holthuijzen, Huanping Huang, Caitlin Crossett

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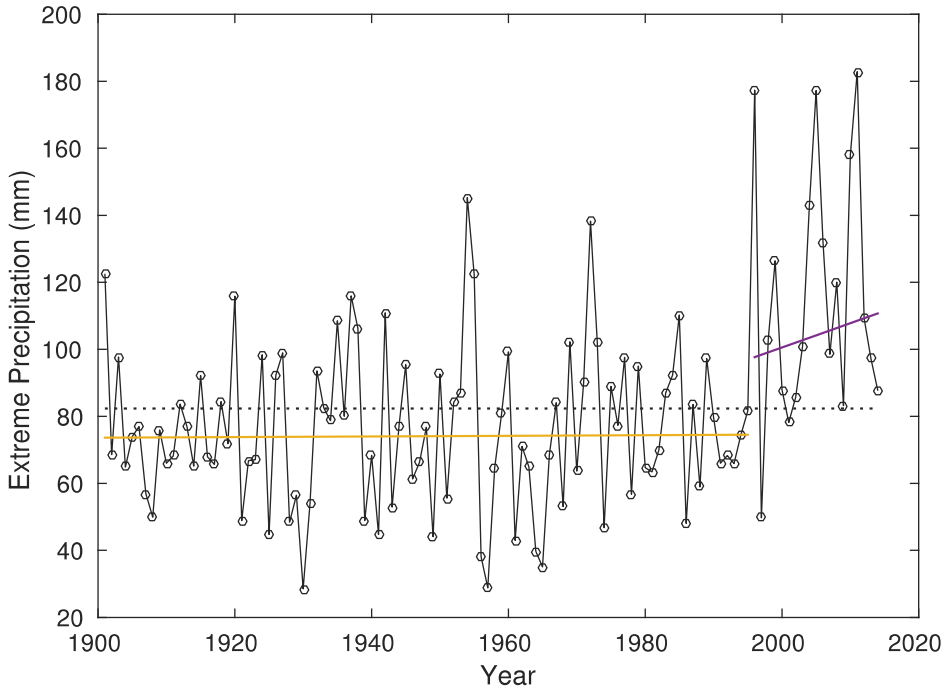
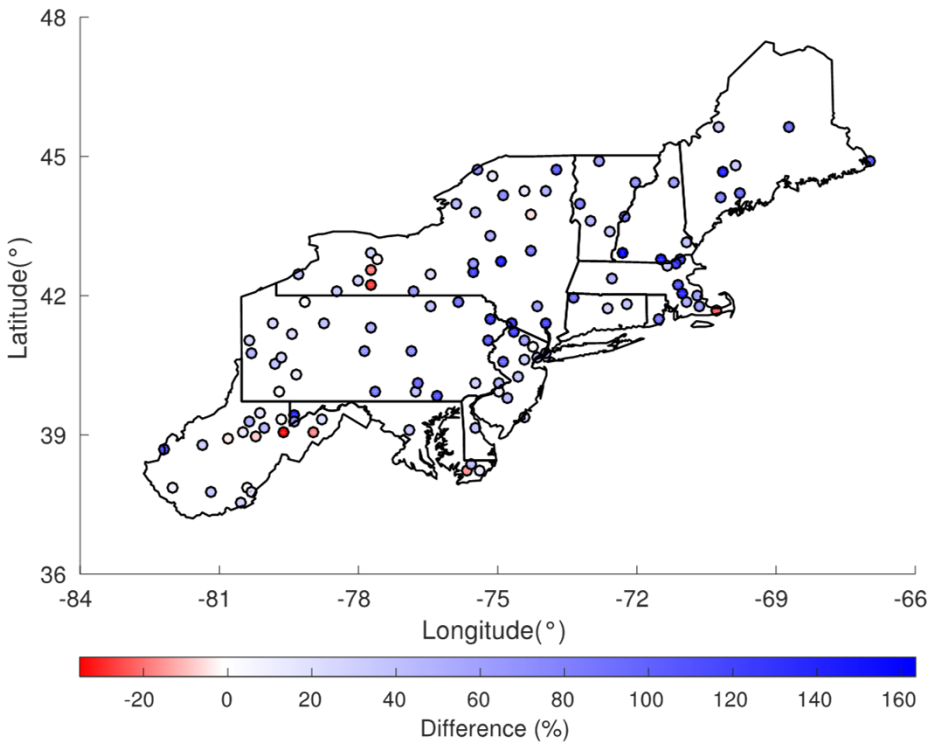
BREE
Basin Resilience to Extreme Events
in the Lake Champlain Basin

The University of Vermont

Northern Vermont
UNIVERSITY

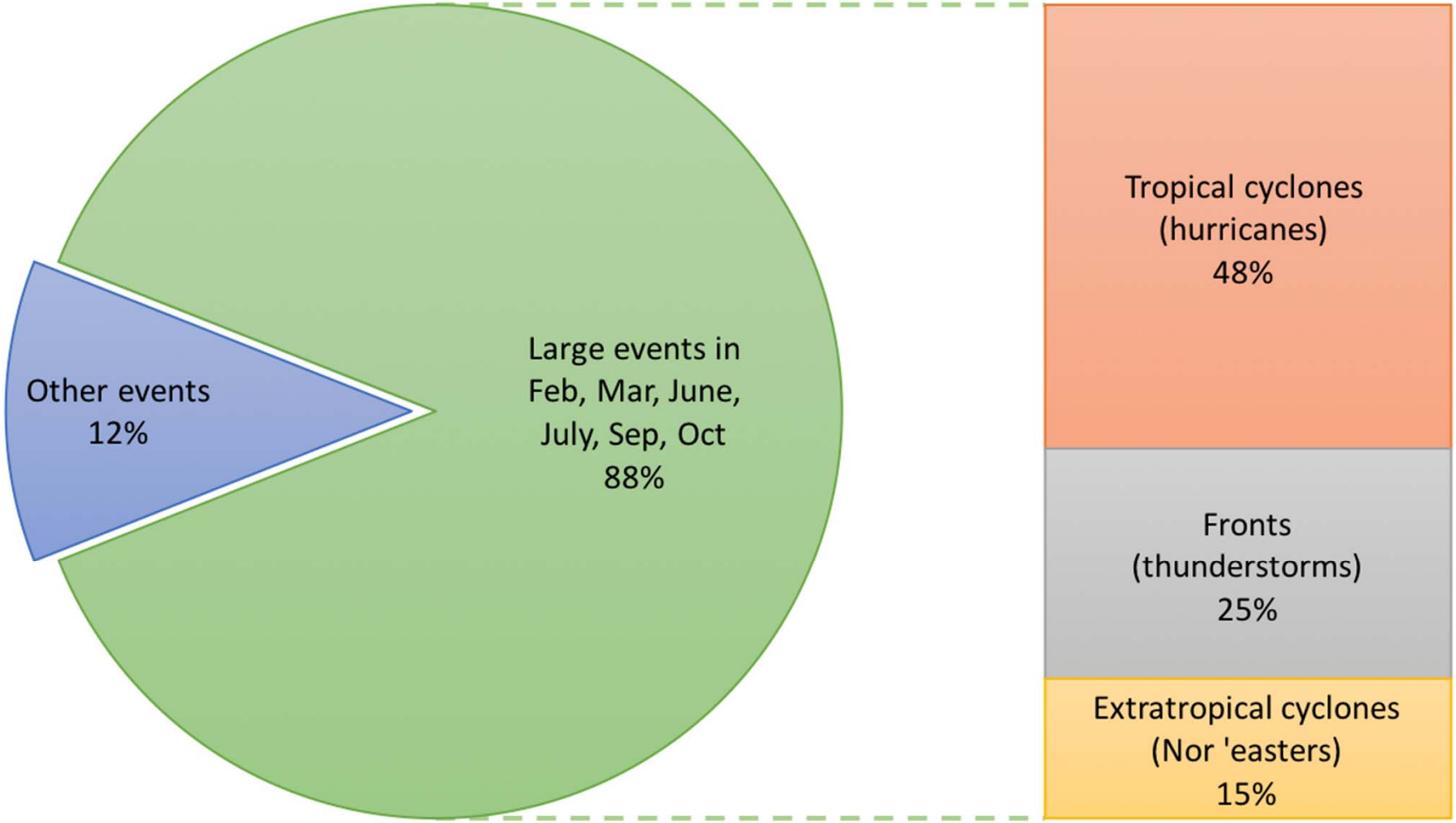
Northeast Extreme Precipitation Events Increased Dramatically 1996-Present





Huang et al., 2017

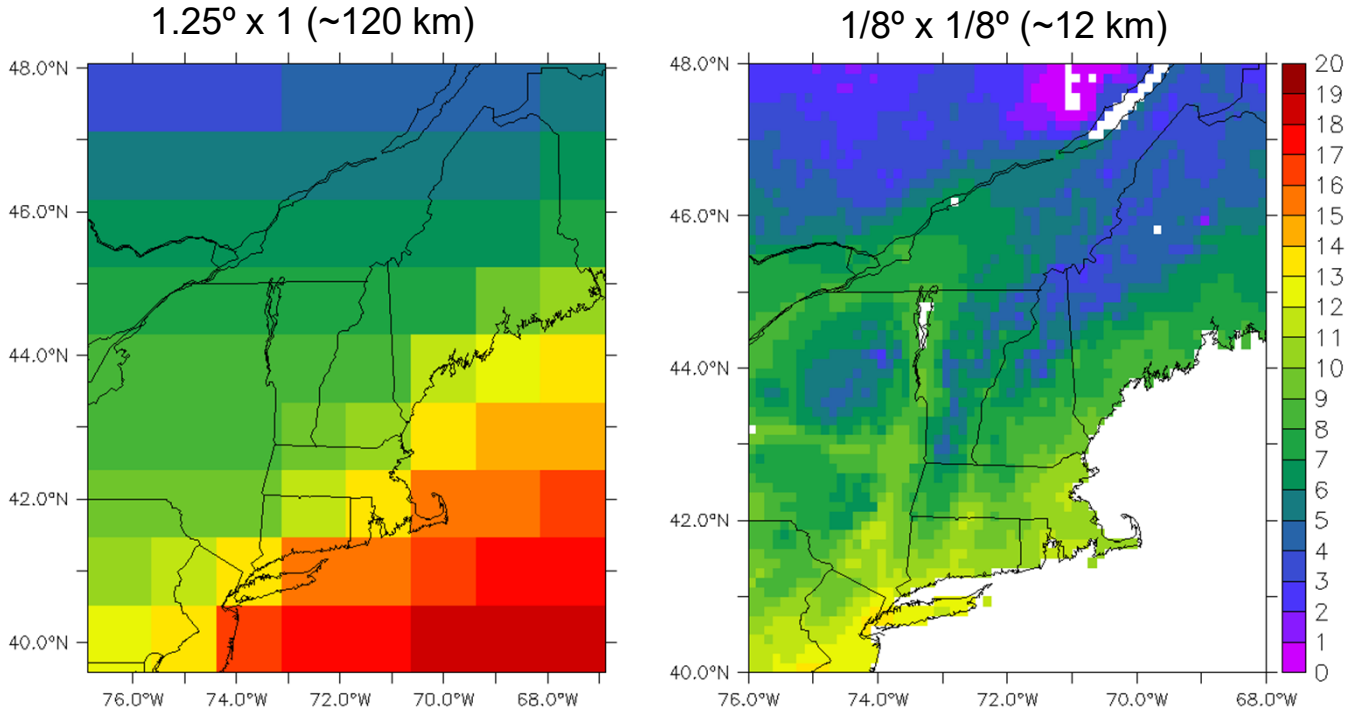
Blame Tropical Cyclones (and Fronts and Extratropical Cyclones)



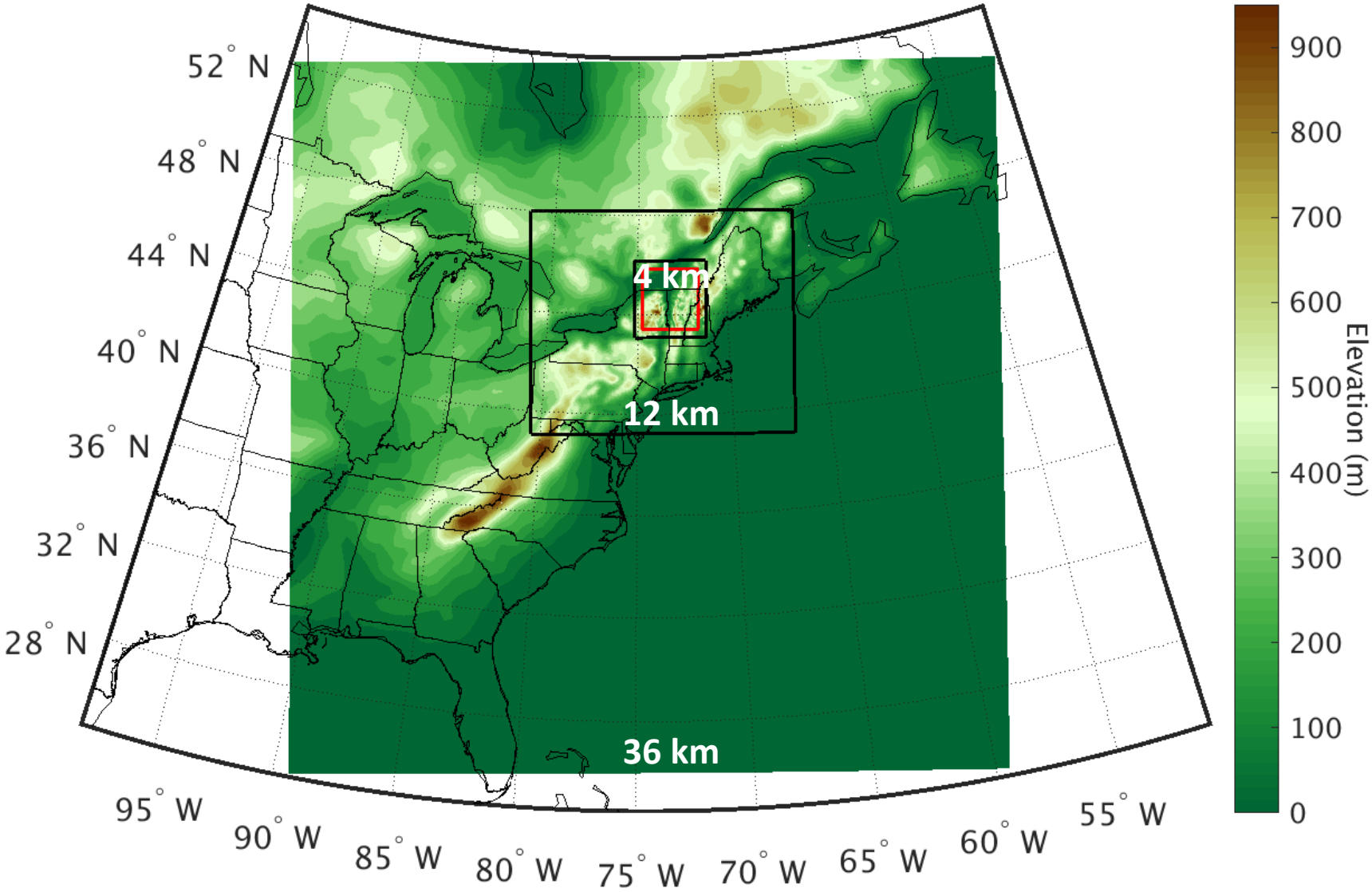
Huang et al., 2018

BREE Climate Team Objectives

1. Deploy, calibrate, and evaluate a regional climate model (Weather Research and Forecasting Model; WRF)
2. Refine WRF to better capture extreme events (e.g., flooding, heatwaves, drought, cold snaps)
3. Include WRF climate scenarios in the IAM



WRF Domains



Huang et al., in review

Test Five Parameterization Schemes Combinations

- Three 5-year periods: 1980-1984, 1995-1999, 2010-2014
- Forced with ERA-Interim Reanalysis
- Compared to Daymet Gridded Observations

Scheme	**CKWY**
Radiation	CAM
Cumulus	Kain-Fritsch
Microphysics	WSM6
Planetary Boundary Layer	YSU

RKWY
RRTMG
Kain-Fritsch
WSM6
YSU

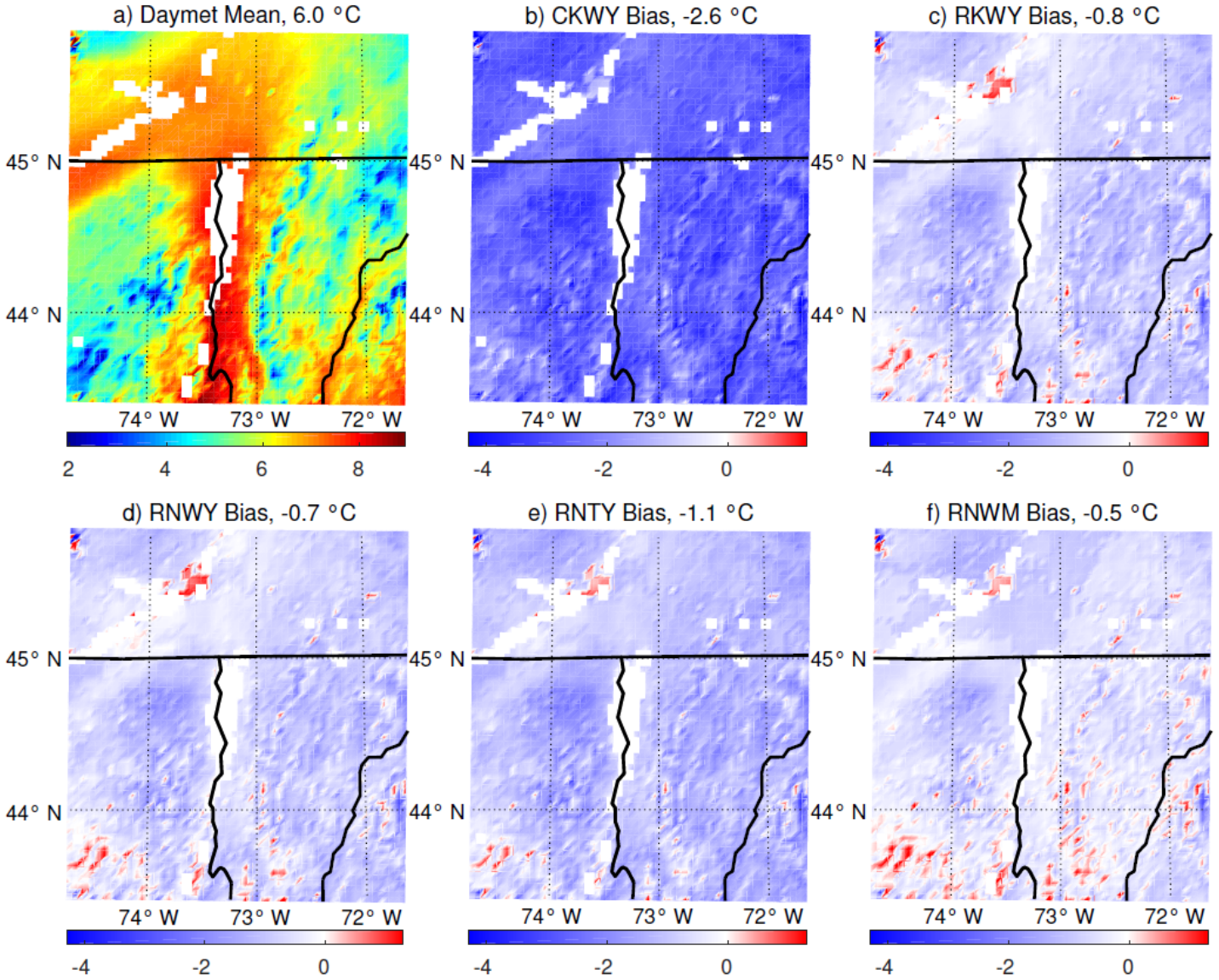
RNWY
RRTMG
New SAS
WSM6
YSU

RNTY
RRTMG
New SAS
Thompson
YSU

RNWM
RRTMG
New SAS
WSM6
MYJ

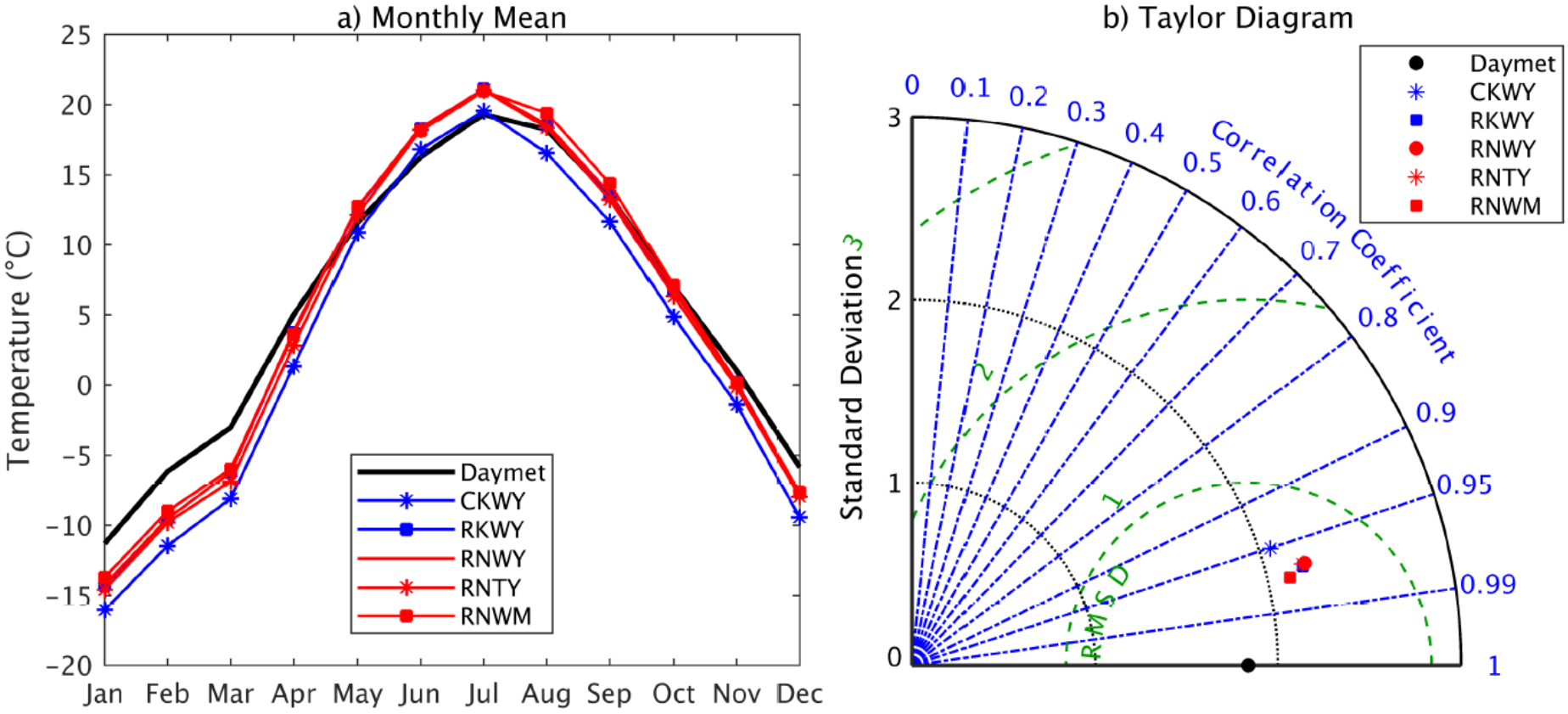
Huang et al., in review

WRF Underestimates Temperature



Huang et al., in review

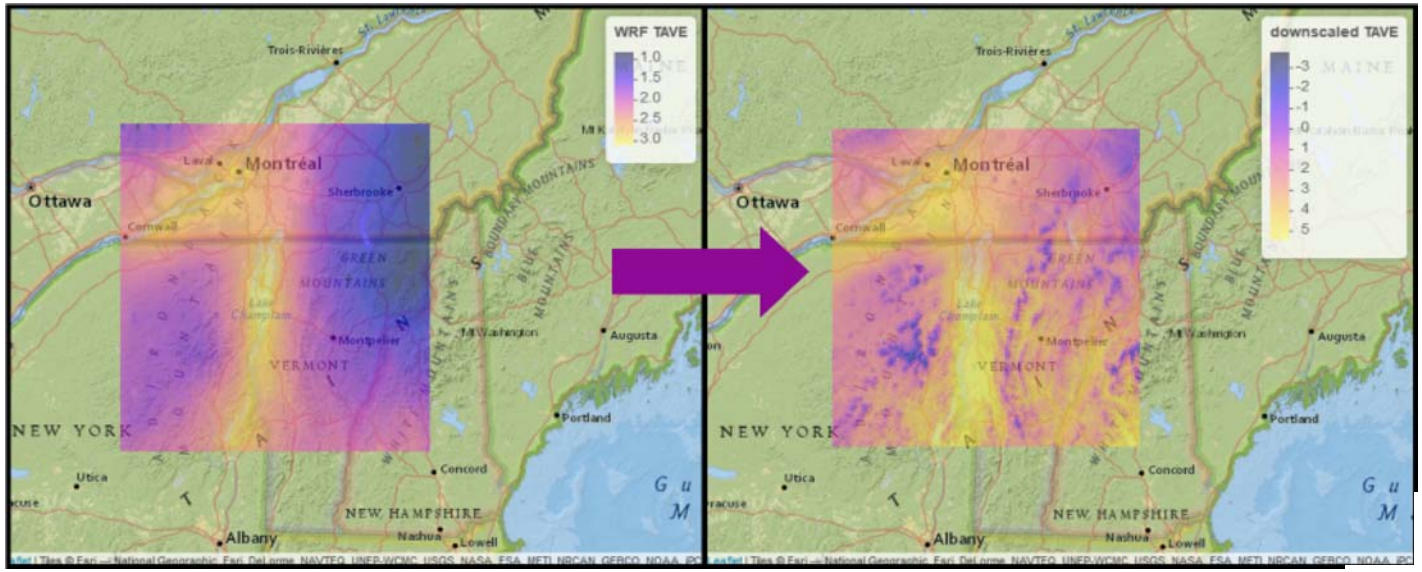
WRF Underestimates Temperature in the Winter, Overestimates in Summer



Huang et al., in review

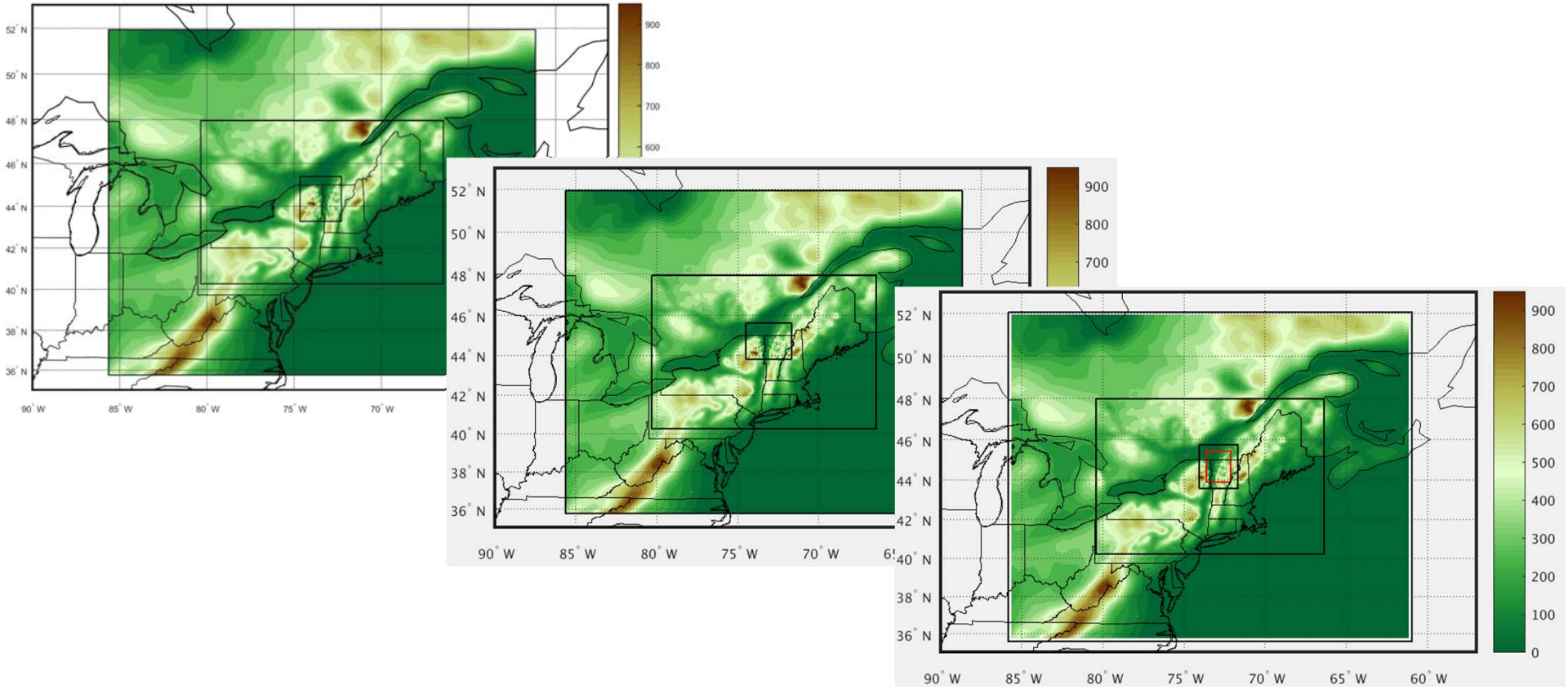
Refine WRF to Better Capture Extreme Events

- Downscale (1 km) and bias correct WRF daily temperature and precipitation data using Bayesian modeling
- Refine WRF temperature and precipitation to better capture extreme climate events
- Team
  - Lead: Brian Beckage
  - Student: Maike Holthuijzen



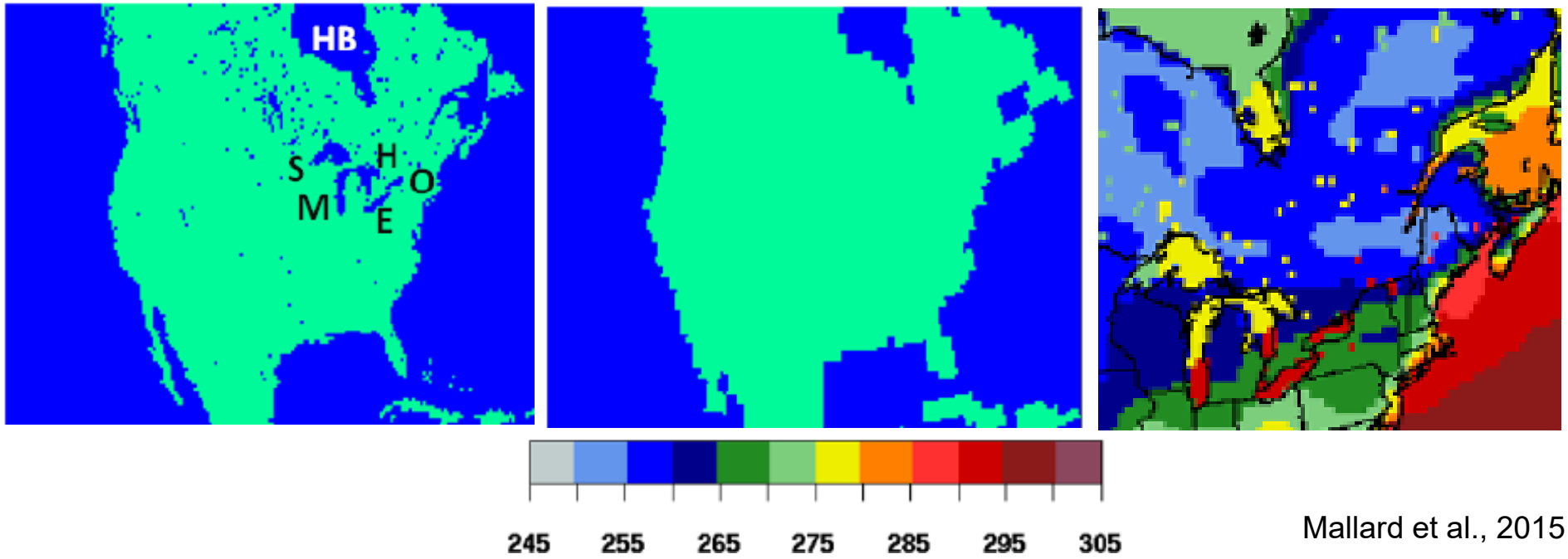
Include WRF Climate Scenarios in the IAM

- Integrate climate scenarios with IAM component models
- Support climate projections for downstream applications
- Team
  - Lead: Patrick Clemins



Assessing the Influence of Lake Temperatures on WRF Simulations

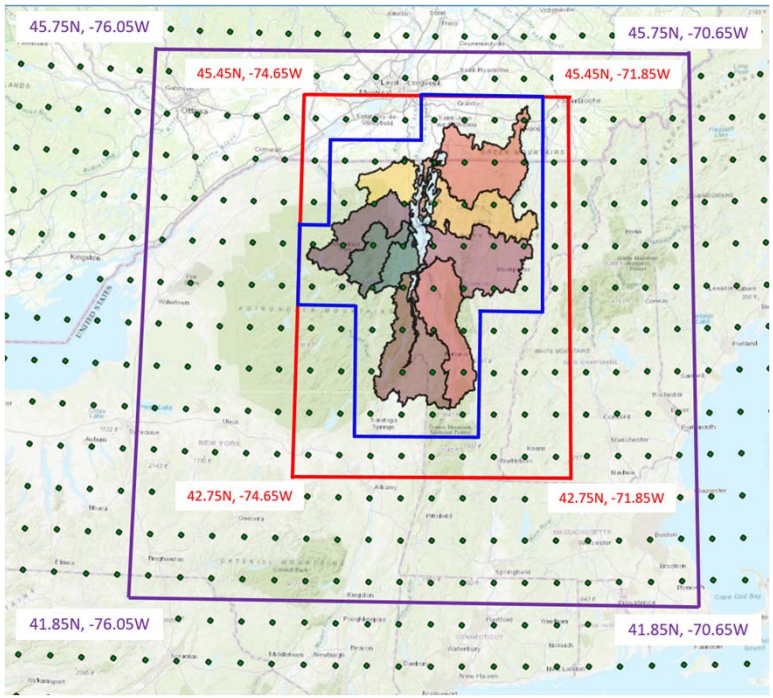
- Motivation
  - Lake temperatures are not provided by GCMs
  - Lake temperatures and evaporative losses are increasing
  - Accuracy may be important when simulating downwind precipitation
- Team
  - Lead: Janel Hanrahan
  - Students: Jessica Langlois and Lauren Cornell



Mallard et al., 2015

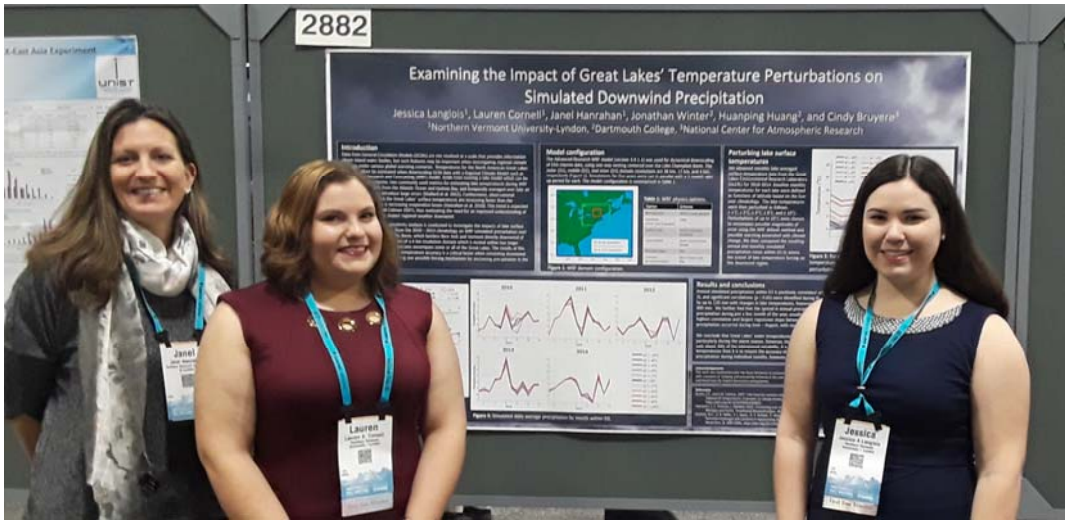
ERA5 Regional Precipitation Analysis

- Analyze synoptic mechanisms of precipitation and precipitation trends across the Lake Champlain Basin
- Explore the impacts of antecedent conditions on flooding
- Team
  - Leads: Arne Bomblies, Lesley-Ann Dupigny-Giroux, Alan Betts
  - Student: Caitlin Crossett



Undergraduate Engagement

- Publications
  - Annals of the American Association of Geographers
  - Journal of Applied Meteorology and Climatology (in review)
- Presentations
  - Plymouth State Undergraduate Research Symposium
  - American Geophysical Union Fall Meeting
  - Northeastern Storm Conference
  - American Meteorological Society Annual Meeting



Publications

J.M. Winter, F. Bowen, J. Chipman, T. Partridge, 2019: Future Extreme Event Vulnerability in the Rural Northeastern United States. *Annals of the American Association of Geographers*, https://doi.org/10.1080/24694452.2018.1540920.

H. Huang, J.M. Winter, and E.C. Osterberg, 2018: Mechanisms of extreme precipitation changes over the Northeastern United States. *Journal of Geophysical Research - Atmospheres*, 123, 7179-7192.

B. Beckage, L.J. Gross, K. Lacasse, E. Carr, S.S. Metcalf, J.M. Winter, P.D. Howe, N. Fefferman, A. Zia, T. Frank, A. Kinzig, and F.M. Hoffman, 2018: Linking Models of Human Behavior and Climate Alters Projected Climate Change. *Nature Climate Change*, 8, 79-84.

H. Huang, J.M. Winter, E.C. Osterberg, R.M. Horton, and B. Beckage, 2017: Total and extreme precipitation changes over the northeastern United States. *Journal of Hydrometeorology*, 18, 1783-1798.

J. Hanrahan, A. Maynard, S. Murphy, C. Zercher, and A. Fitzpatrick, 2017: Examining the Climatology of Shortwave Radiation in the Northeastern United States. *Journal of Applied Meteorology and Climatology*, https://doi.org/10.1175/JAMC-D-16-0420.1

Presentations and Outreach

J.M. Winter, H. Huang, E.C. Osterberg, B. Beckage, J. Hanrahan: Simulating Future Climate in the Lake Champlain Basin: Methods, Limitations, and Uncertainties. International Joint Commission Climate Risk Workshop, Montreal, Canada, 19 March 2019.

H. Huang, J.M. Winter, J. Hanrahan, C.L. Bruyère, P. Clemins, and B. Beckage: Simulating extreme precipitation in the Lake Champlain basin using a regional climate model: Limitations and uncertainties. 2018 AGU Fall Meeting, Washington D.C., USA, 11 December 2018.

J.M. Winter, F.L. Bowen, J.W. Chipman, T.F. Partridge: Future Extreme Event Vulnerability in the Rural Northeastern United States. American Geophysical Union Fall Meeting, New Orleans, USA, 11 December 2017.

J.M. Winter, H. Huang, and E.C. Osterberg: Total and Extreme Precipitation Changes over the Northeastern United States. American Association of Geographers Annual Meeting, Boston, USA, 7 April 2017.

H. Huang: Climate change and its implications on extreme weather and biodiversity. AP Biology, Hartford High School, Hartford, Vermont, 31 May 2019.