

Climate Change Scenarios for Lake Champlain Basin Impacts Assessments

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VT EPSCoR Climate Team

Research Questions

- What is the response of precipitation and temperature to climate change over the Lake Champlain Basin?
- Can global climate model projections be usefully downscaled for high-resolution (~ 1 km) hydrologic and land use modeling?
- What are the critical uncertainties in predicting climate change impacts?



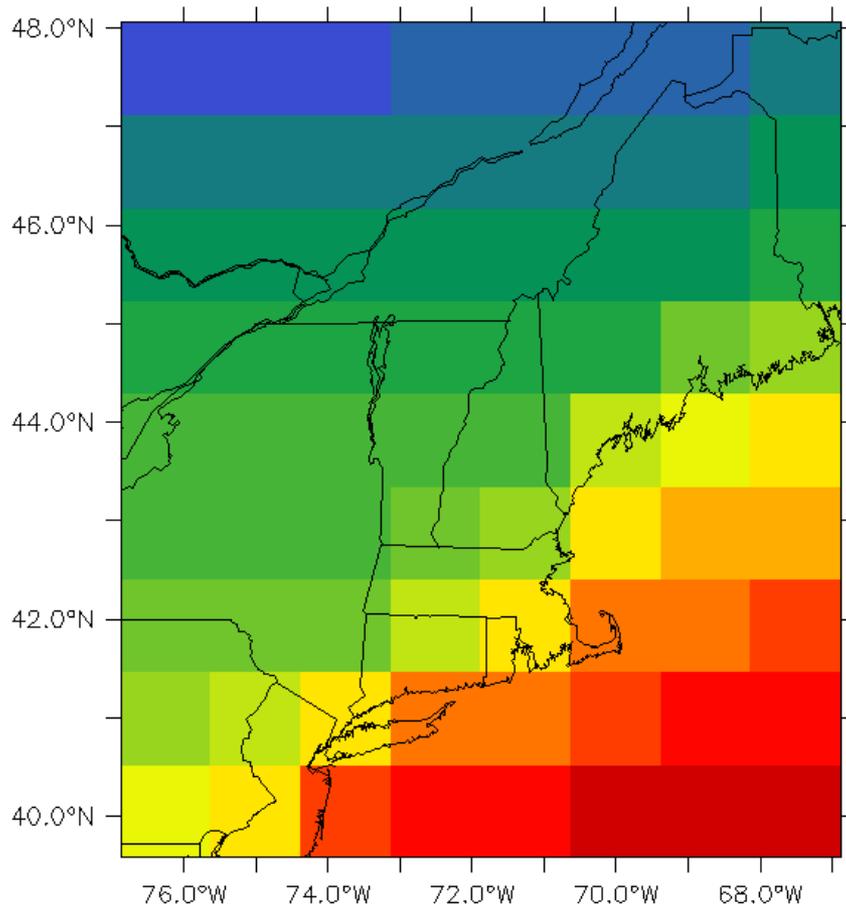
GCMs Predict Climate Response to Increased Greenhouse Gas Concentrations

- Global Climate Models (GCMs) solve the primitive equations (conservation of momentum, mass, and energy) to simulate fluid flow on a spherical surface
- Global spatial coverage
- Contain significant inaccuracies
- Coarse resolution

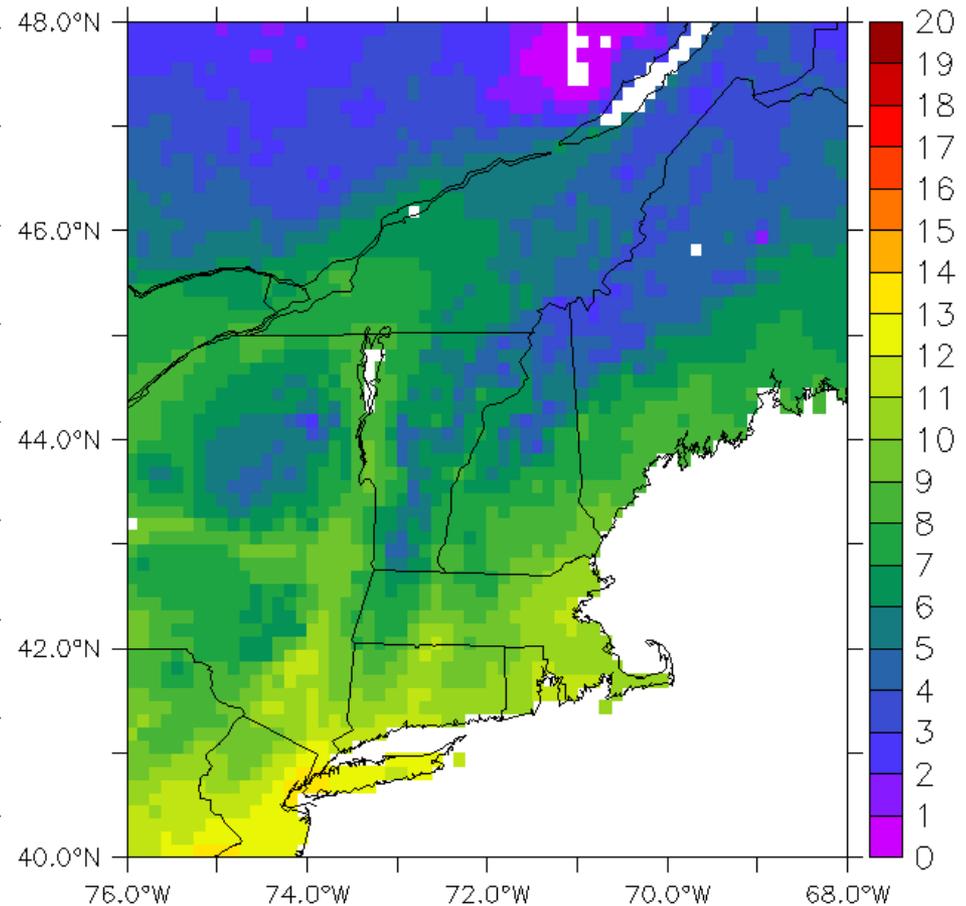


Statistical Downscaling Bias Corrects and Increases Resolution of GCM Projections

1.25° x 1° (~120 km)

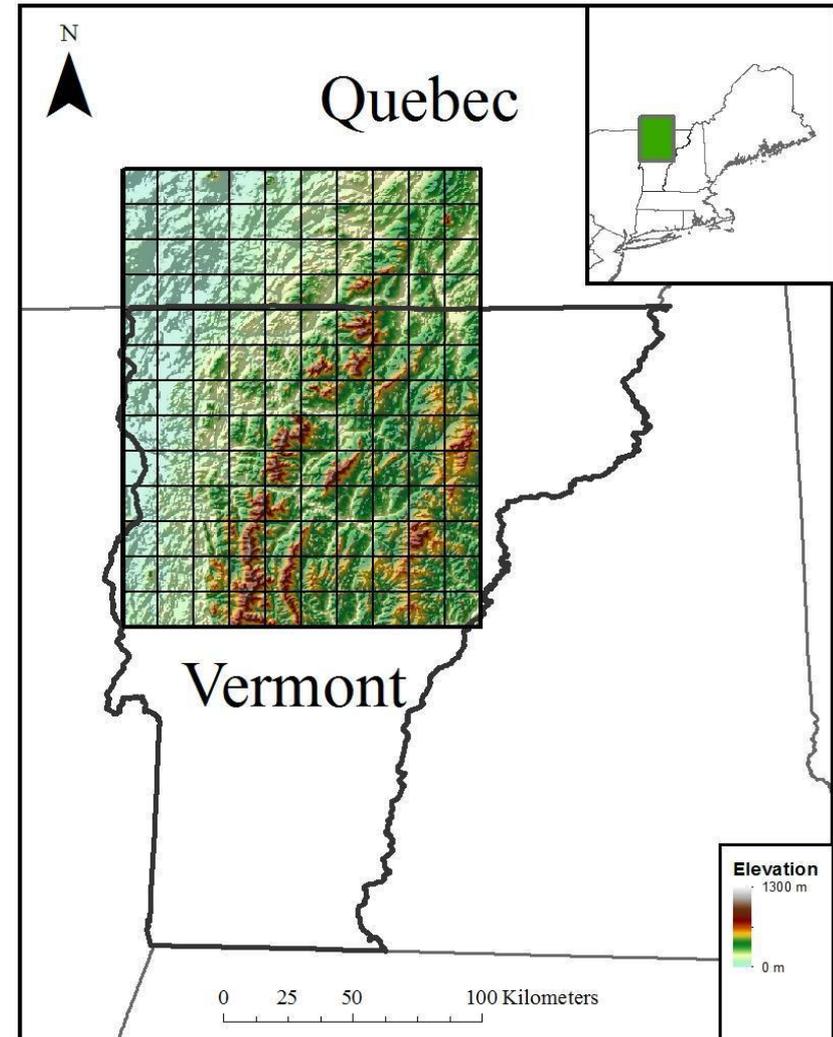


1/8° x 1/8° (~12 km)

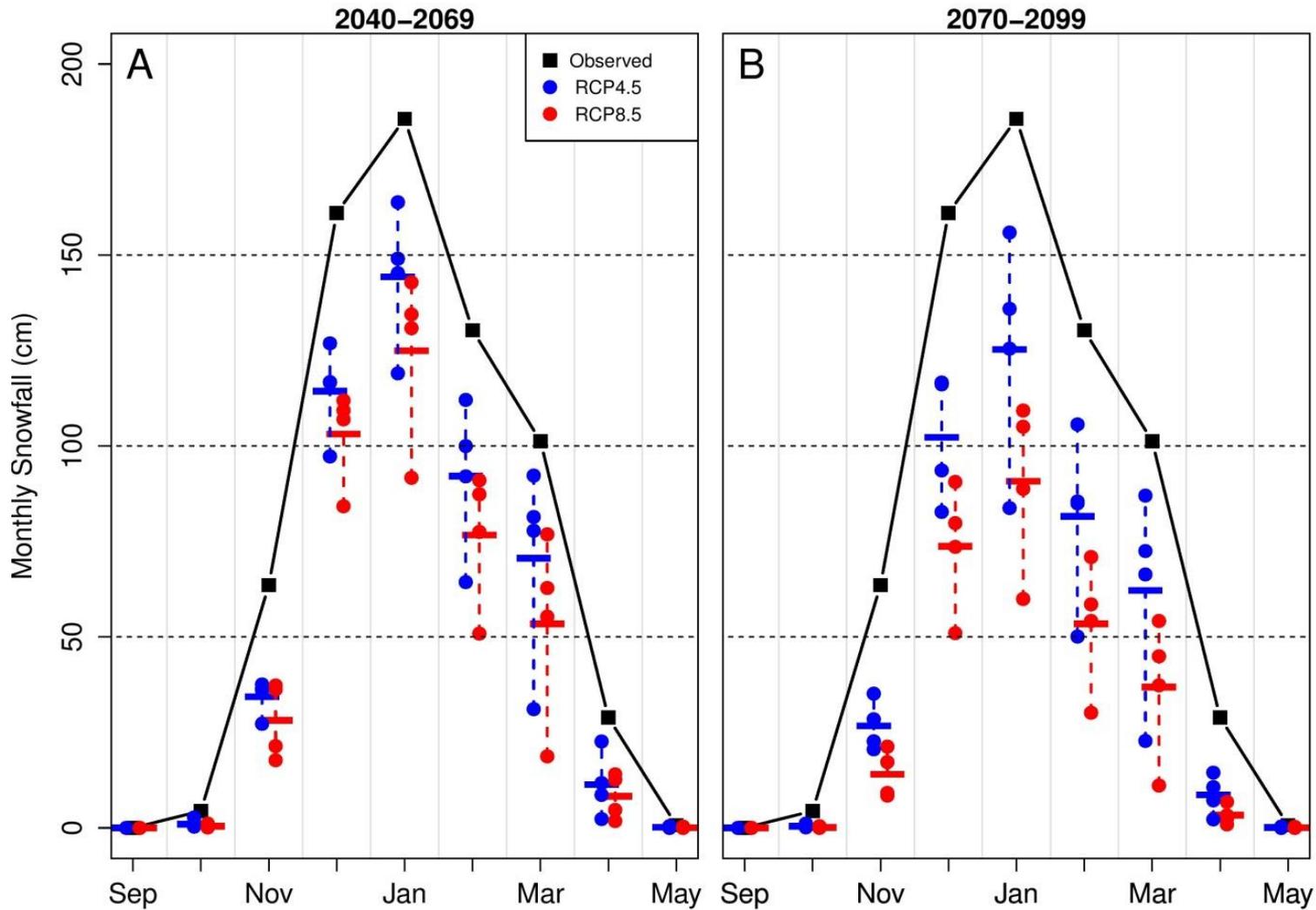


Assessing Climate Change in the Lake Champlain Basin using Statistically Downscaled Data

- Difference between mid-century (2040-2069), end-of-century (2070-2099) and historical (1970-1999) climate
- Two Representative Concentration Pathways (RCPs): 4.5 and 8.5
- CMIP5, 4 GCMs: CSIRO-MK3 (wet), IPSL-CM5 (dry), MIROC-ESM (warm), INM-CM4 (cool)
- Bias-Corrected with Constructed Analogues (BCCA; Brekke et al., 2013)

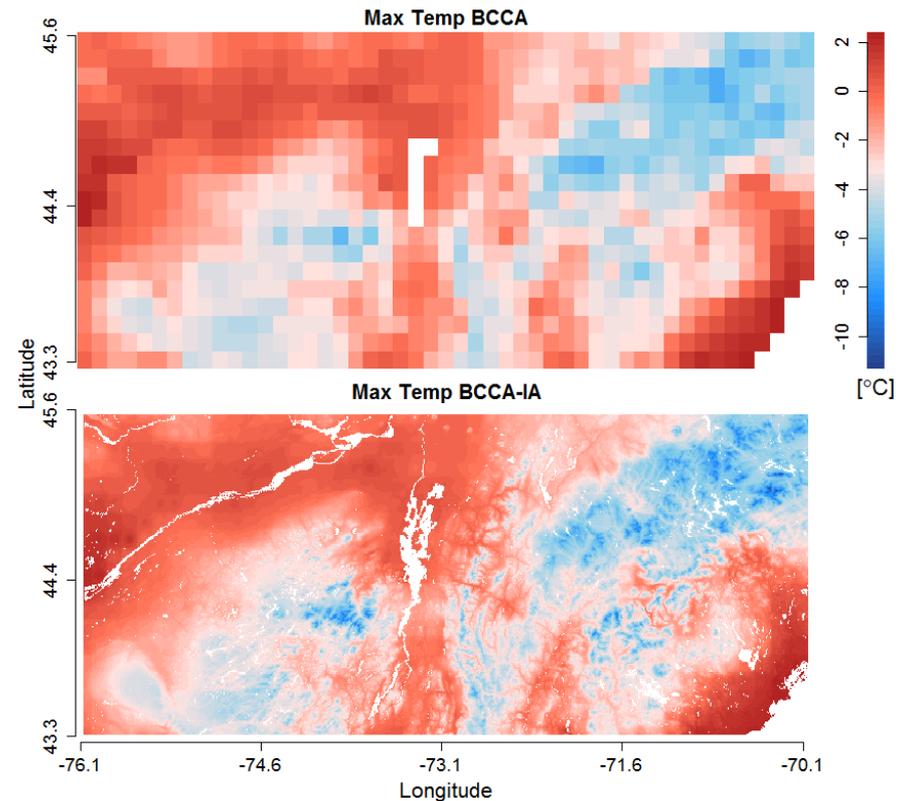


Snowfall Will Decrease



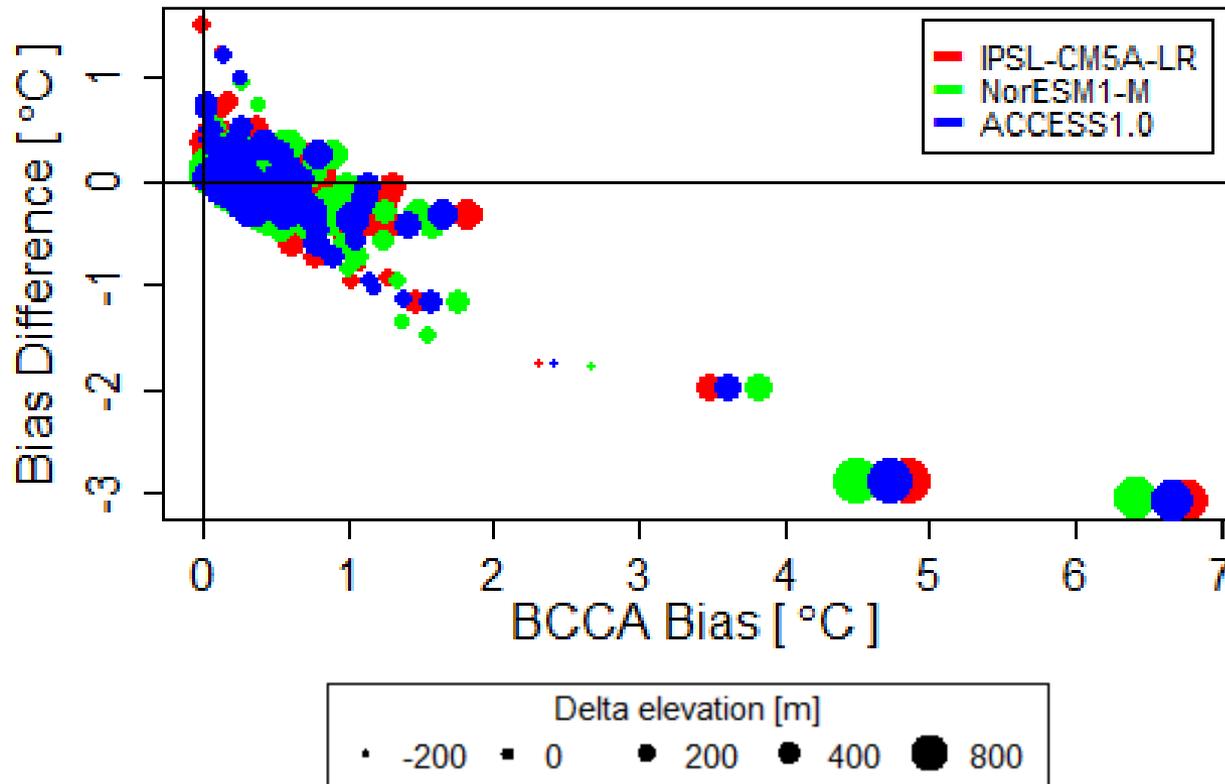
Leverage Topographic Data to Create Very High Resolution Climate Scenarios

- Downscale $1/8^\circ$ Bias-Corrected with Constructed Analogues data (~ 12 km) to $30''$ (~ 1 km)
 1. Derive observed temperature and precipitation elevation adjustments from station data
 2. Translate variables to a reference elevation using adjustments and intermediate resolution DEM
 3. Interpolate data to increase spatial resolution
 4. Create high resolution variables by modifying interpolated data using adjustments and high resolution DEM



Topographic Downscaled Data Analysis: Bias Evaluation, Maximum Temperature

- For low elevations, elevation adjustments may exacerbate or ameliorate biases, though the change will be small
- As initial bias and elevation differences increase, the ability of topographic downscaling to reduce bias also increases



Publications, Products, and People

Publications

- Winter, J.M., B. Beckage, G. Bucini, R.M. Horton, and P.J. Clemins: Development and Evaluation of High-Resolution Climate Simulations over the Mountainous Northeastern United States. *Journal of Hydrometeorology*, in press.
- Gilbert, J., A. K. Betts, D. M. Rizzo, B. Beckage, and A. Bomblied, 2015: Characterization of increased persistence and intensity of precipitation in the Northeastern United States. *Geophysical Research Letters*.
- Betts, A.K., R. Desjardins, D. Worth and B. Beckage, 2014: Climate coupling between temperature, humidity, precipitation and cloud cover over the Canadian Prairies. *Journal of Geophysical Research - Atmospheres*, 119.
- Guilbert, J., B. Beckage, J.M. Winter, R.M. Horton, T. Perkins, and A. Bomblied, 2014: Impacts of projected climate change over the Lake Champlain Basin in Vermont. *Journal of Applied Meteorology and Climatology*, 53, 1861-1875.
- Huang, H., J.M. Winter, E.C. Osterberg, R.M. Horton, and B. Beckage: Assessing changes in mean and extreme precipitation over the Northeastern United States. in prep.
- Bucini, G., J.M. Winter, B. Beckage, P.J. Clemins, J. Clavens, J. Page, and R.M. Horton. Daily Weather Estimator for Climate Projections Based on Nearest Neighbor Resampling. in prep.

Products

- High-resolution (~1km) downscaled data for RCP4.5 (20 GCMs), RCP6.0 (5 GCMs), RCP8.5 (20 GCMs)
- Six presentations at professional conferences, including Association of American Geographers Annual Meeting, American Geophysical Union Fall Meeting, International Association for Great Lakes Research
- Four public talks, including New Hampshire Association of Conservation Districts, Institute for Lifelong Education at Dartmouth, Dartmouth Council on Climate Change, Upper Valley Sierra Club, Vermont Public Radio, Local Fox Affiliate
- Results informed multiple lectures for *Global Climate Change; Climate Change and the Future of Agriculture; Complexity, Climate Change, and Human Systems*.
- Publically available R package for weather estimation

People

- Five senior personnel across three institutions
- Two graduate students
- Four undergraduates, including two VT EPSCoR interns