Impacts on Northern Great Plains Infrastructure and Agriculture from Climate Change using Regional Climate Modeling Ensembles

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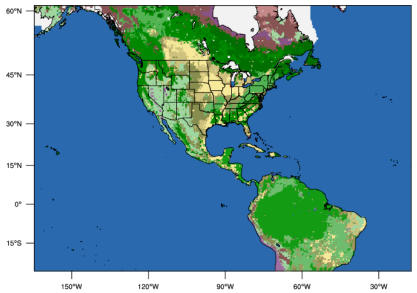
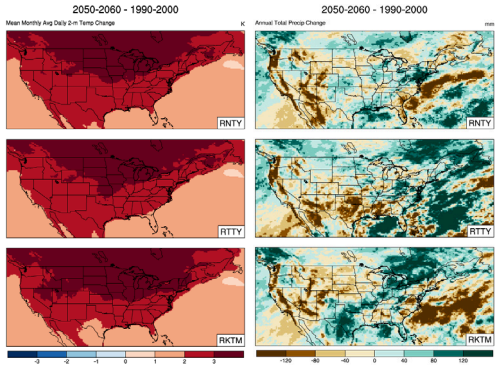
North America Climate Ensembles

To to assess impacts of regional climate change over the US and Northern Great Plains, we are using WRF-ARW to downscale global CESM RCP 8.5 simulations to a three-member multi-physics ensemble with a Δx of 36 km.

Member	RKTM	RNTY	RTTY
Radiation	RRTM	RRTM	RRTM
Cumulus	Kain-Fritsch	NSSL	Tiedtke
Microphysics	Thompson	Thompson	Thompson
PBL	MYJ	YSU	YSU



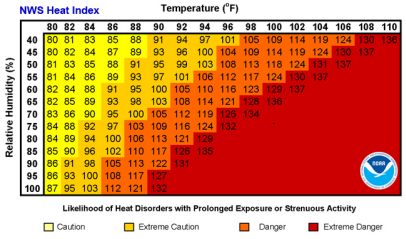
For each physics set, five WRF simulations into the 21rst century (1990-2000, 2020-2030, 2030-2040, 2050-2060 and 2080-2090) were run over North America. Hourly output, aggregated to monthly and annual increments was extracted for each simulation clipped over the contiguous US, and daily increments clipped over the South Dakota.



Fragility Indices

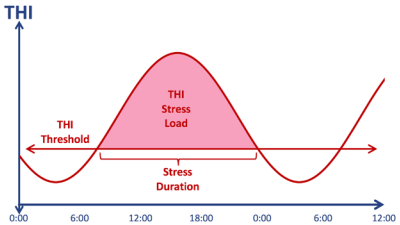
Fragility Indices were collected including values from the ETCCDI Climate Change Indices, including Growing Season Length, Heating, Cooling and Growing Degree Days, Wet/Dry Spell Lengths (Karl et al, 1999).

Also collected were NWS Heat Index (NHI) and Temperature-Humidity Index (THI) used to assess heat stress for people and livestock, respectively.



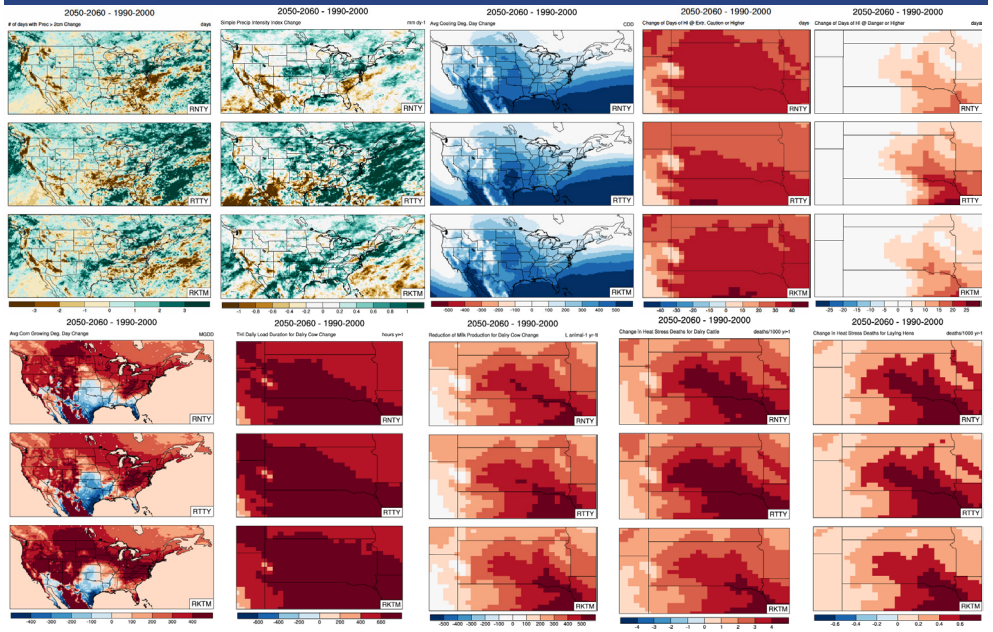
$$THI = 41.2 + T^{\circ C} + 0.36\,T_d^{\circ C}$$

THI is used to assess livestock stress for a given species by the length of time THI exceeds a species-specific threshold (stress duration) and the integrated exceedance of the THI threshold which are then correlated to specific livestock impacts such as deaths from heat exposure and loss of production (St. Pierre, 2003).



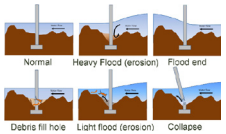
This allows us to associate an impact to economic sectors and apply an economic cost to climate change with the caveat that many of the fragility indices are calibrated to contemporary climate and related loads.

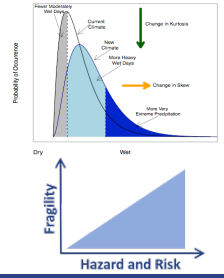
Select Results



Ongoing Work

- Apply methods to alternative scenarios, RCP cases and ensembles
- Assess impact of increased temperatures on construction working days, pavement and bridge reliance and flood frequency
- Associate economic cost to livestock loss
- Update THI livestock fragility curves to account for higher long-term temperatures
- Develop probability curves for hazard forcings (temperature, precipitation, etc.) and fragility under future scenarios.





References

Karl, T.R., N. Nicholls, and A. Ghazi, 1999: CLIVAR/GCOS/WMO workshop on indices and indicators for climate extremes: Workshop summary. *Climatic Change*, **42**, 3-7.

St-Pierre, N.R., B. Cobanov, and G. Schnitkey. 2003: Economic losses from heat stress by U.S. livestock industries. *J. Dairy Sci.*, **86**: E52–E77.

We would like to acknowledge high-performance computing support from Yellowstone (ark:/85065/d7wd3xhc) provided by NCAR's Computational and Information Systems Laboratory, sponsored by the National Science Foundation.