# Future Heat Stress Projections and their Effects on US Livestock

Emma McCabe,[1] Jonathan R. Buzan,[1] Srinath Krishnan,[2] and Matthew Huber[3]

Corresponding author: ecg38@wildcats.unh.edu

## Introduction:

Future climate change may result in variations in heat stress experienced by livestock, which will consequently impact agricultural health, well-being, and yield. In this study, we estimated future yield changes for livestock due to heat stress in the United States. We use Community Land Model version 4.5 (CLM 4.5), a component of the Community Earth System Model (CESM) that was developed by the National Center for Atmospheric Research (NCAR). The simulation uses RCP8.5 boundary conditions. We added the HumanIndexMod (Buzan et al. 2015). We computed heat stress metrics such as Temperature Humidity Index for Comfort (THIC) and 2m air temperature. We conducted retrospective simulations driven by reanalysis of past observed climate data, and future climate scenarios driven by an ensemble of future climate model projections.

## Background:

- Heat stress is the measure of thermal load on humans and animals.
- THI = temperature humidity index; THILoad is the integral of the daily THI values that lie above THI threshold.
- The temperature humidity index for comfort (THIC) indicates the conditional threat levels for animals: 75 is alert, 79-83 is dangerous and 84 and above is very dangerous (Buzan et al., 2015).
  THIC is a modification of the Temperature humidity index and is unitless.

## Methods:

- We use CRUNCEP for our historical simulation (Casado et al., 2013).
- We calculate yields for our models, Dairy Cow: dry matter intake loss, and milk Loss (DMILoss_DC and MilkLoss_DC), Growth Finished Hog: gain loss and dry matter intake loss (GainLoss_GF) and (DMILoss_GF) and Poultry Layers: Egg loss (EggLoss_PL) (St. Pierre et al., 2003)
- We use CLM 4.5 (Oleson et al., 2013) to map our projections.
- RCP8.5 greenhouse gasses concentrations. (Meinshausen et al., 2011).
- The simulation was from 2005 to 2034, and 2071 to 2100
- T-test was conducted for all the livestock models (stipple in figures) and anomalies are plotted along with the appropriate unit conversions.

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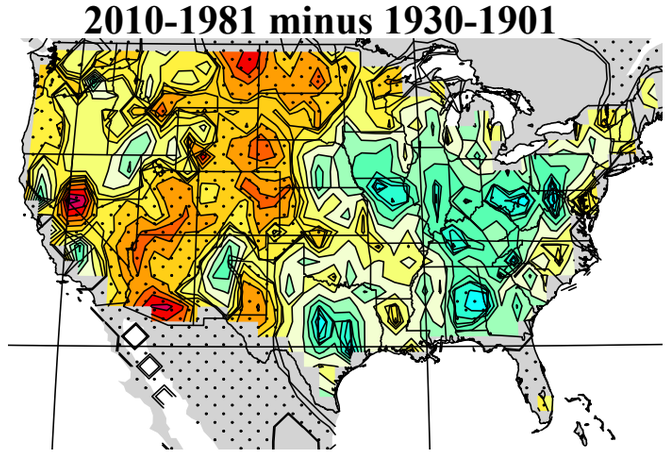
**Affiliation**

1) University of New Hampshire, Durham, New Hampshire, USA.

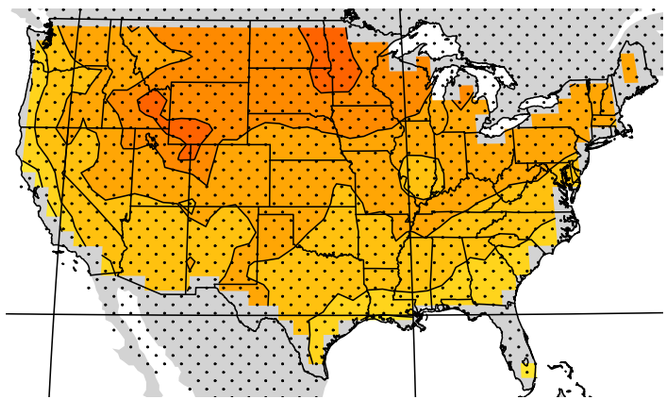
2) Yale University, New Haven, Connecticut, USA

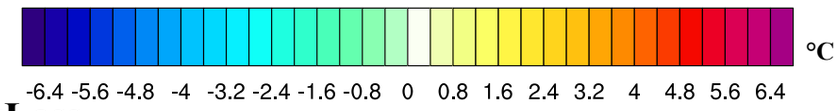
3) Earth Systems Research Center, Institute for the Study of the Earth, Oceans, and Space, University of New Hampshire, Durham, New Hampshire, USA.

**2 m Temperature**
**2010-1981 minus 1930-1901**

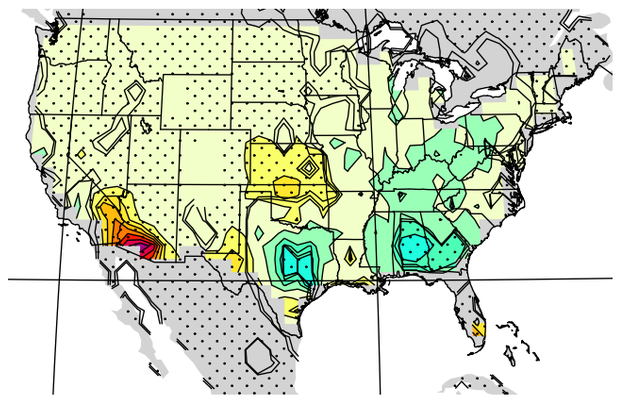


**2 m Temperature**
**2100-2071 minus 2034-2005**

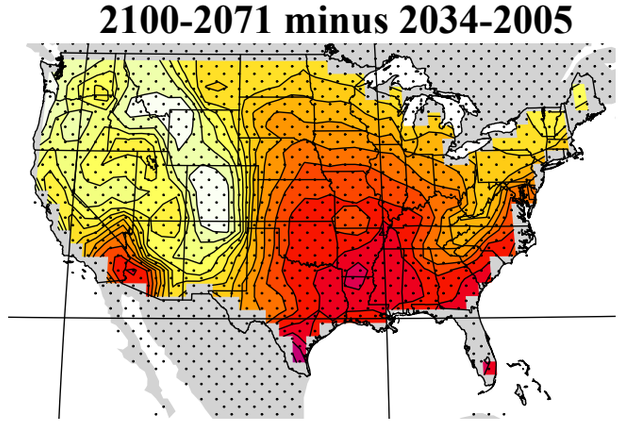


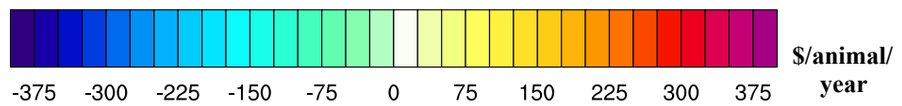



**Dairy Cow MilkLoss**
**2010-1981 minus 1930-1901**

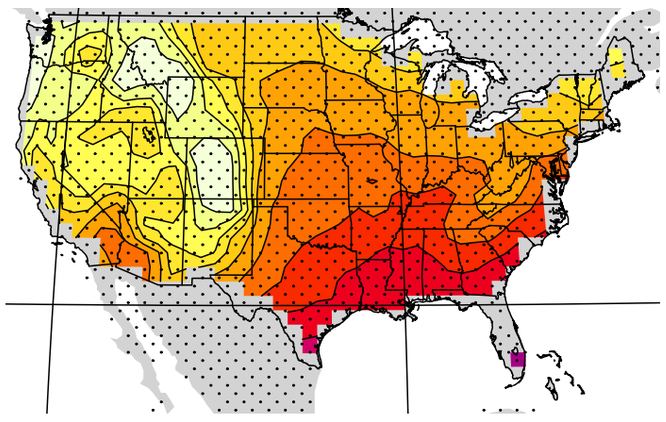


**Dairy Cow MilkLoss**
**2100-2071 minus 2034-2005**

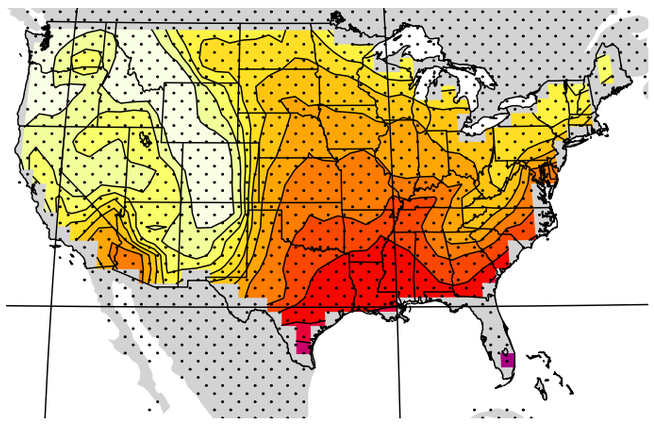


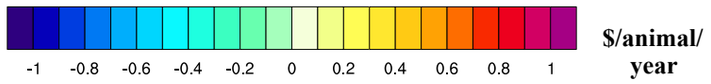


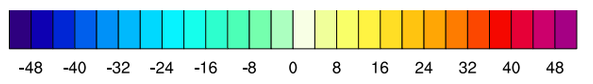

**Poultry Layers EggLoss**
**2100-2071 minus 2034-2005**



**Growth Finished Hog GainLoss**
**2100-2071 minus 2034-2005**






## Yield Losses

| | 2005-2034 | 2071-2100 | Difference | Relative Loss |
|---|---|---|---|---|
| Dairy Cow DMI Loss (1000's $/lbs of food) | 24.7 | 1172 | 1148 | 4645% |
| Dairy Cow Milk Loss ($/gal) | 0.05 | 0.121 | 0.071 | 142% |
| Growth Hog DMI Loss (1000's $/lbs of food) | 465 | 964 | 498 | 107% |
| Poultry Lay Egg Loss ($/egg) | 0.08 | 0.15 | 0.07 | 87.5% |

## Conclusions:

- 2 m Temperature is projected to increase by the end of the century across the U.S. (2071-2100).
- This increase results in a negative effect on yields.
- The temporal anomalies convey greater losses in the South Eastern USA.
- We calculate differences in yield for each livestock model.
- We take spatial averages and calculate monetary losses.
- In the 21st century each type of livestock exhibits a loss; the DairyCow yields the largest losses, in both food intake and milk production (see Table: Yield Losses).

**Citations:**

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