

It's the Heat AND the Humidity – Assessment of Extreme Heat Scenarios to Enable the Assessment of Climate Impacts on Public Health

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Objective

To provide historical and future measures of climate-driven heat events to enable assessments of heat impacts on public health over the conterminous U.S.

Methods

- Use GCM output for past and future climate to determine changes in monthly mean temperature and humidity.
- Use meteorological re-analysis data to characterize past spatial and temporal patterns of excessive heat.
- Use re-analysis data, adjusted with GCM 'deltas', to create daily high-resolution future scenarios of excessive heat.
- From these future scenarios, calculate yearly and longer metrics of excessive heat.

GCMs

- We obtained GCM output of monthly mean minimum and maximum daily temperatures and monthly mean specific humidity.
- Source: Coupled Model Intercomparison Project (CMIP3) Multi-Model Dataset Archive at Program for Climate Model Diagnosis and Intercomparison (PCMDI).

Scenarios:

20th Century Climate for 1980 -1999

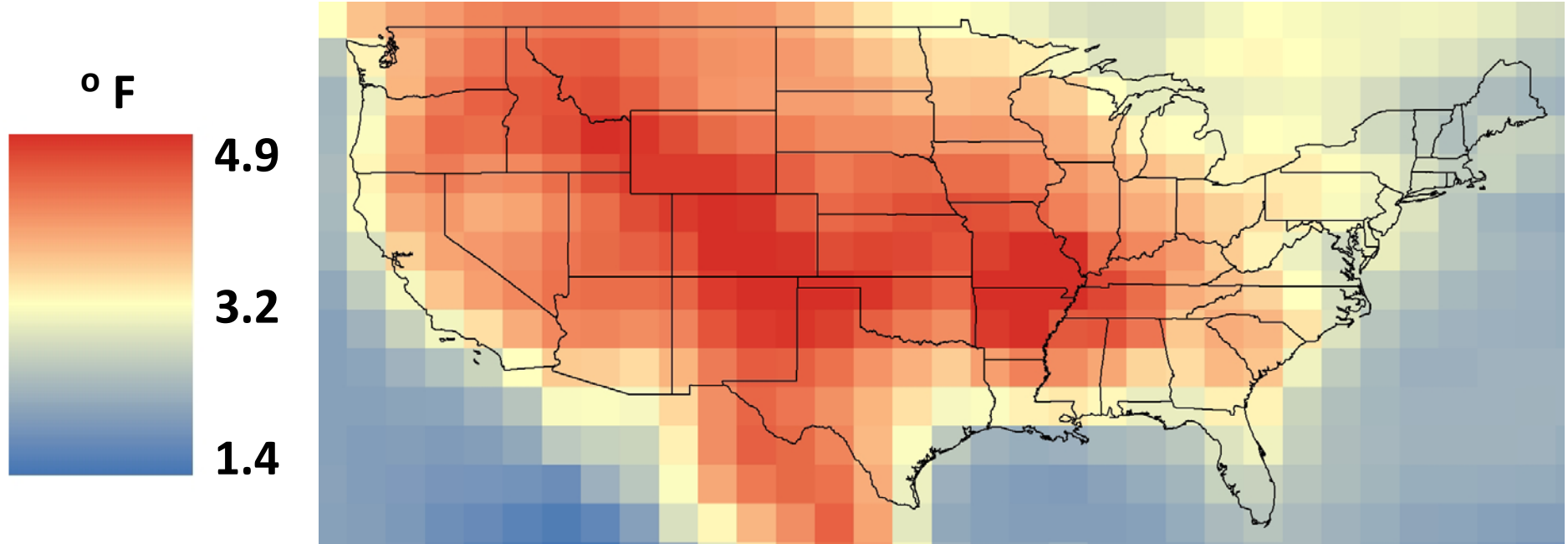
SRES A2 ('Business as Usual') for 2030-2049 and 2080-2099

| | <u>Model</u> | <u># Ensemble members used</u> |
|----|-----------------------------|--------------------------------|
| 1. | CCSM3 (NCAR) | 2 |
| 2. | CSIRO-MK3.0 (Australia) | 2 |
| 3. | CSIRO-MK3.5 (Australia) | 3 |
| 4. | BCCR-BCM2.0 (Norway) | 1 |
| 5. | INM CM3.0 (Russia) | 1 |
| 6. | MIROC 3.2 Med. Res. (Japan) | 3 |

Means of each variable were computed across ensembles, then across models. Differences ('deltas') were computed for each variable for each calendar month between future and 20th Century climates.

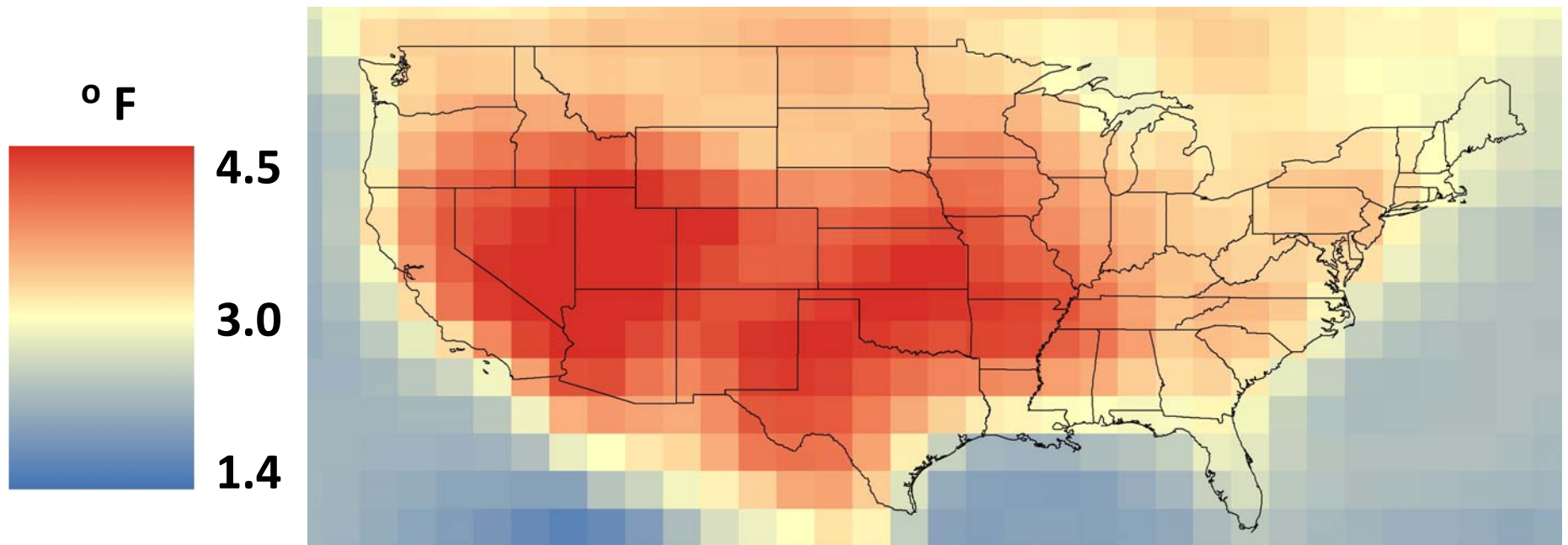
Mean Maximum Temperature Difference - August

2040 – 1990, Average of all models, all ensemble members, A2 scenario



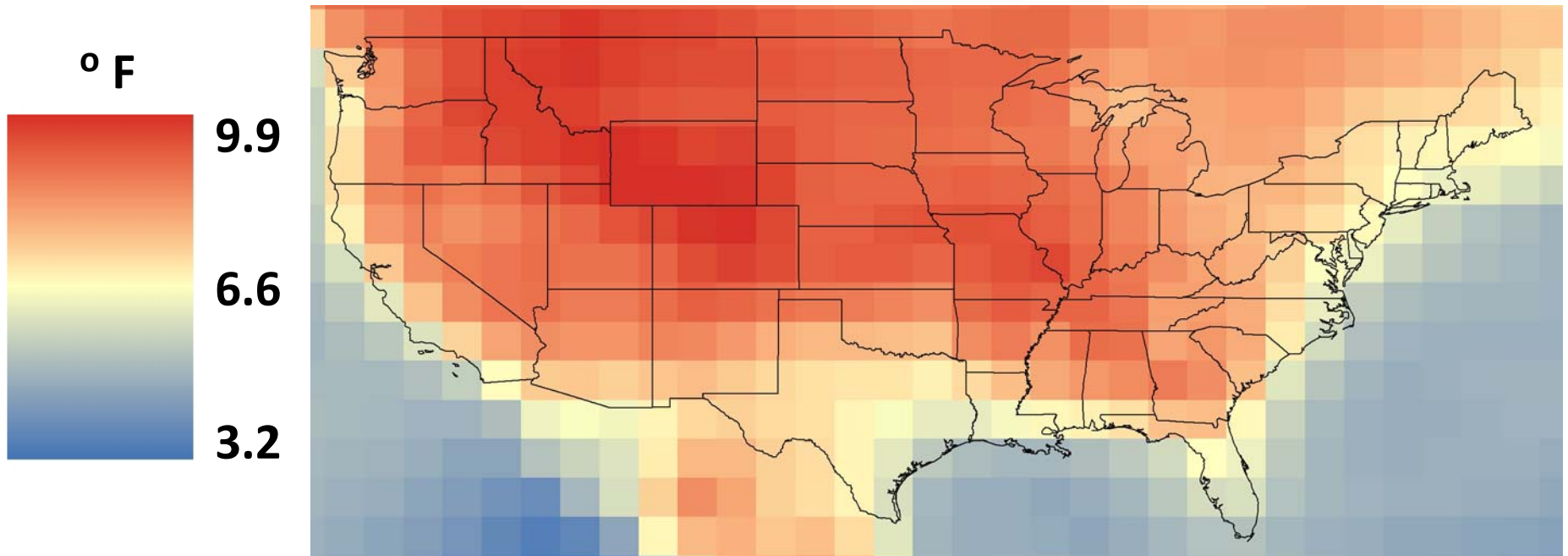
Mean Minimum Temperature Difference - August

2040 – 1990, Average of all models, all ensemble members, A2 scenario



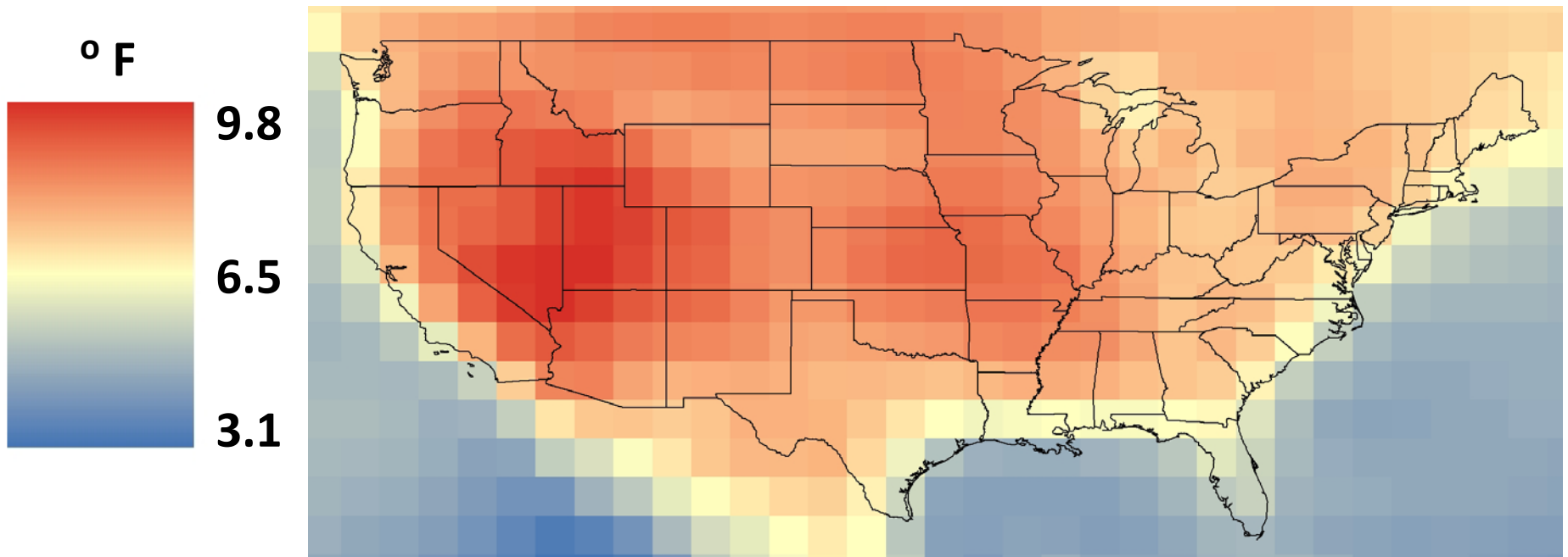
Mean Maximum Temperature Difference - August

2090 – 1990, Average of all models, all ensemble members, A2 scenario



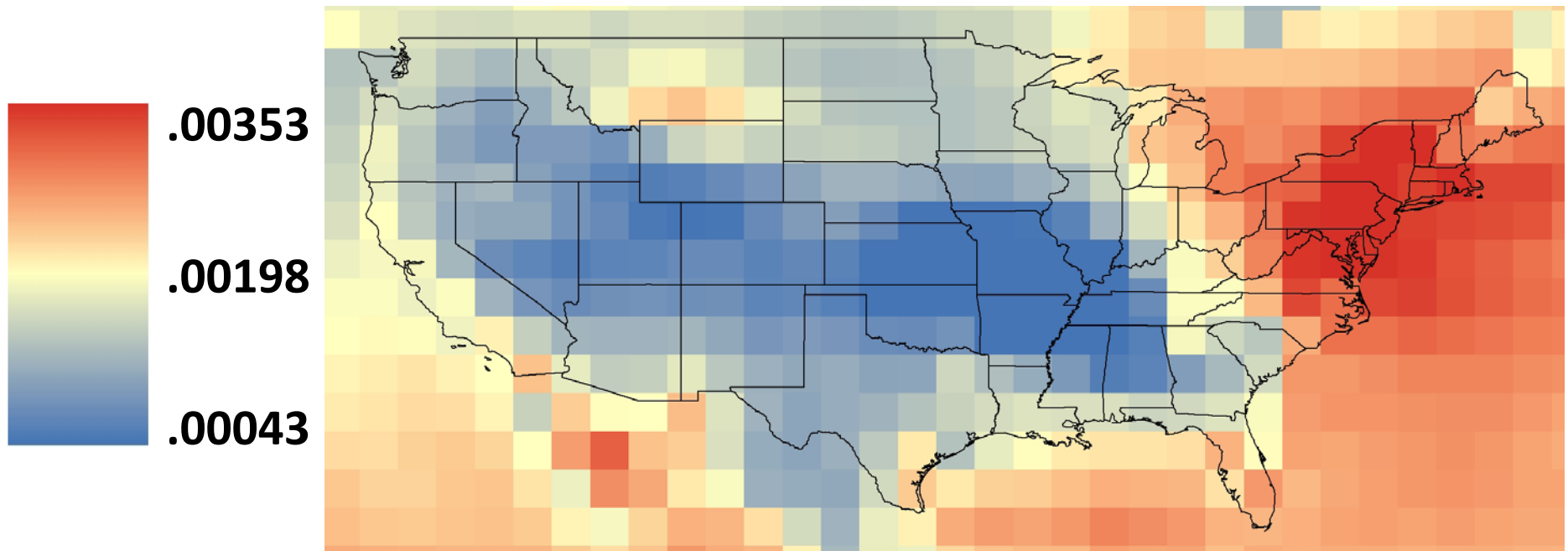
Mean Minimum Temperature Difference - August

2090 – 1990, Average of all models, all ensemble members, A2 scenario



Mean Specific Humidity Difference - August

2090 – 1990, Average of all models, all ensemble members, A2 scenario



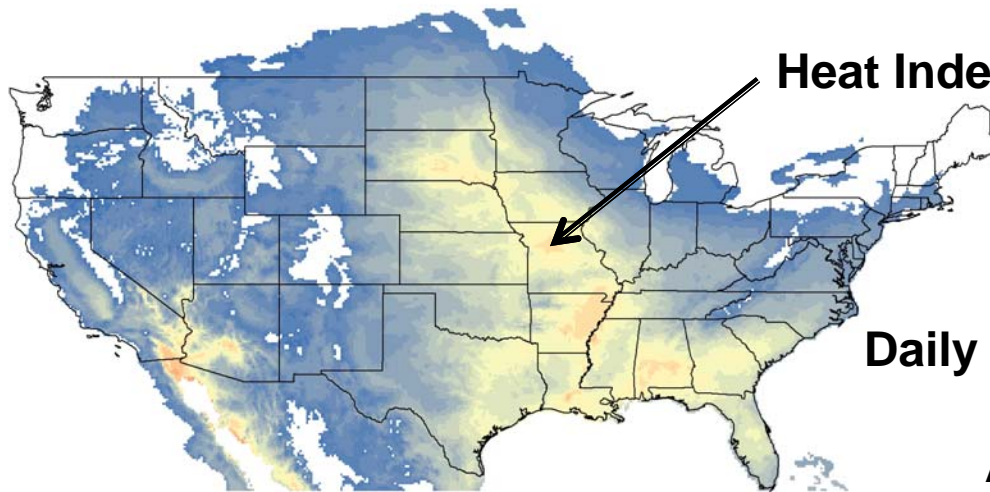
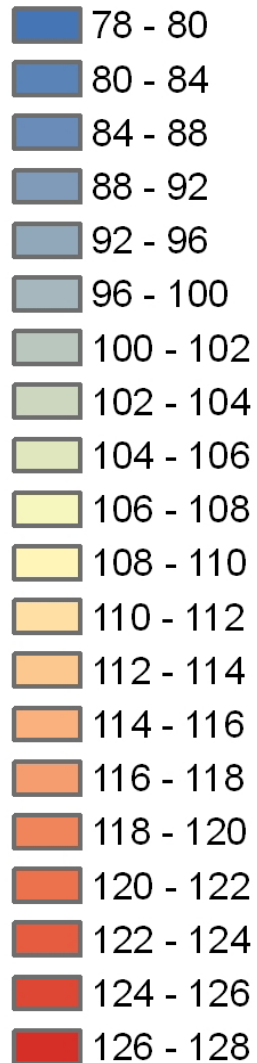
North American Land Data Assimilation System (NLDAS)

- North American Land Data Assimilation System (NLDAS) provides modeled meteorological data for the conterminous United States.
 - 1/8th degree (about 13 km) spatial resolution
 - Hourly data
- We converted hourly NLDAS data from GRIB-1 format to grid-level daily maximum and minimum temperature and other heat-related variables from 1979-2011.
- NLDAS data are available from:
<http://www.emc.ncep.noaa.gov/mmb/nldas/>

Example of current and future climates

Daily maximum Heat Index

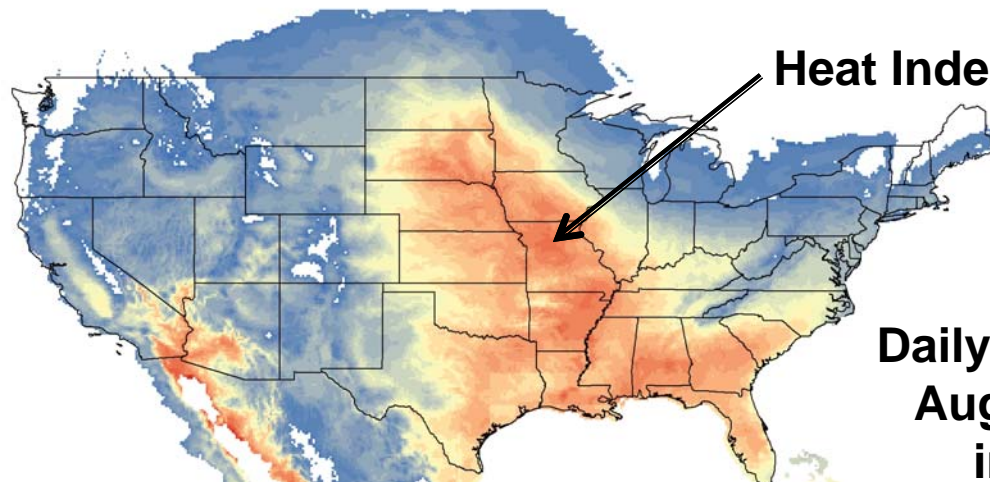
Heat Index (°F)



Heat Index = 111 °F

Daily maximum Heat Index
from NLDAS
August 13, 2007

Add 2040-1990 Δ -climate (temperature & humidity) to obtain HI projections:



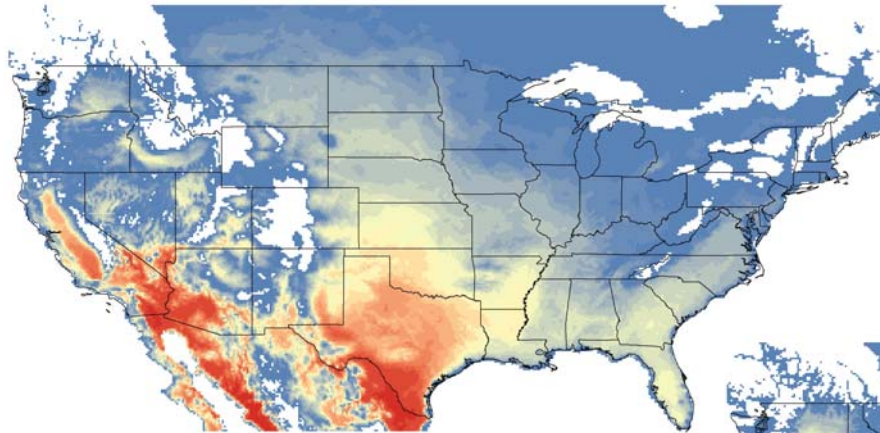
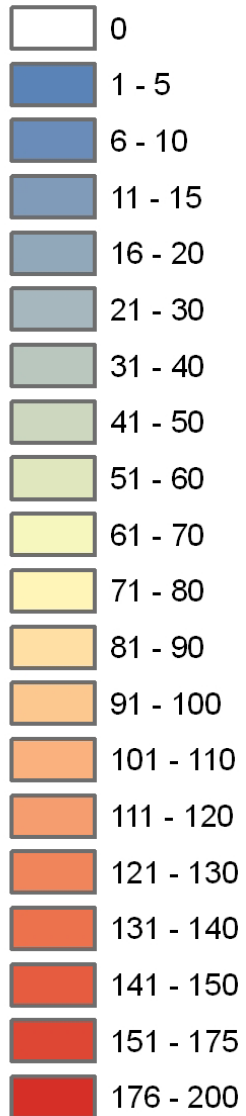
Heat Index = 121 °F

Daily maximum Heat Index
August 13, 2007 analog
in 2050 A2 climate

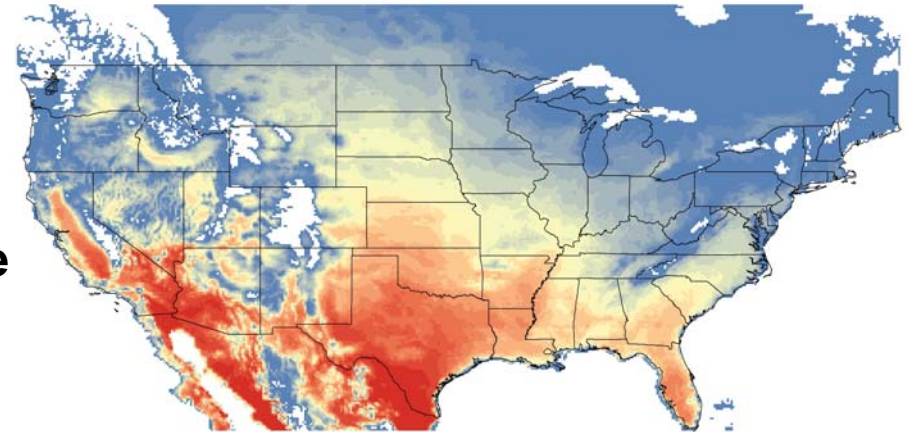
Example of current and future climates

Mean annual number of days, maximum temperature > 90 °F

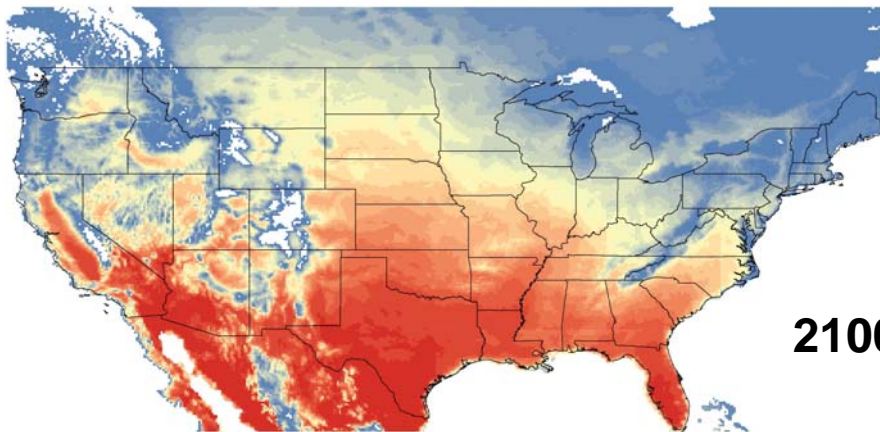
Annual days



1991-2010 NLDAS data



2050 A2 climate

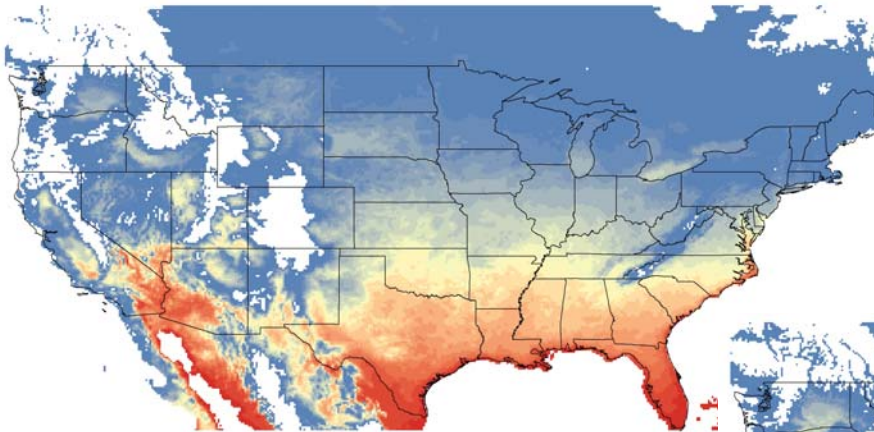
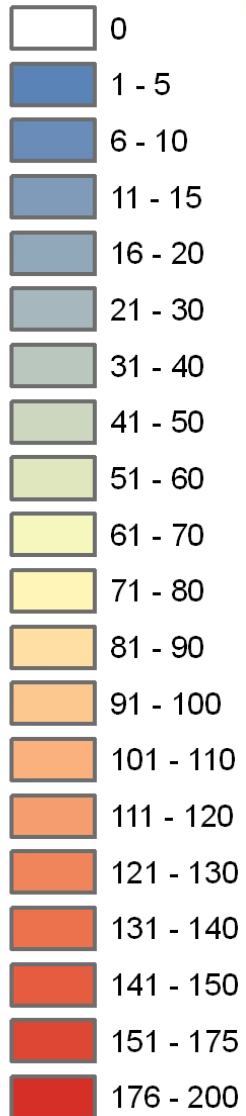


2100 A2 climate

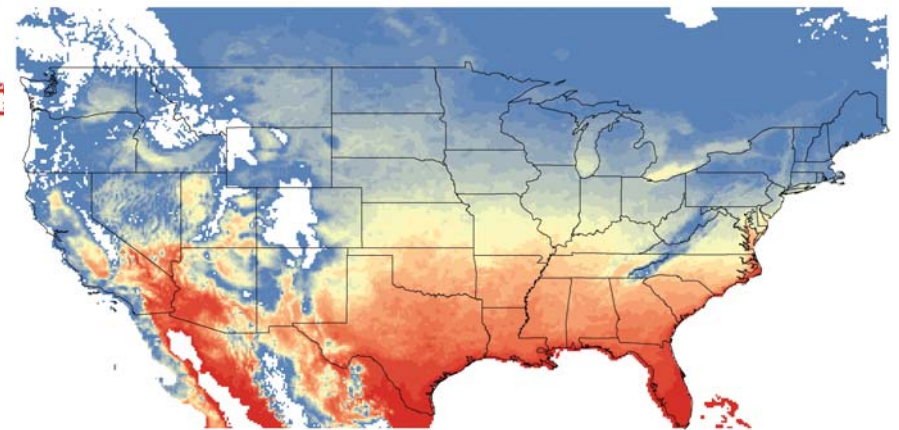
Example of current and future climates

Mean annual number of days, minimum temperature > 70 °F

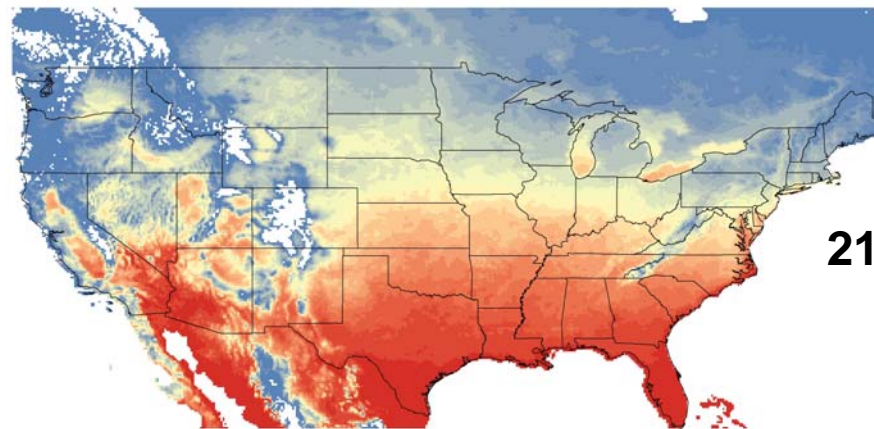
Annual days



1991-2010 NLDAS data



2050 A2 climate

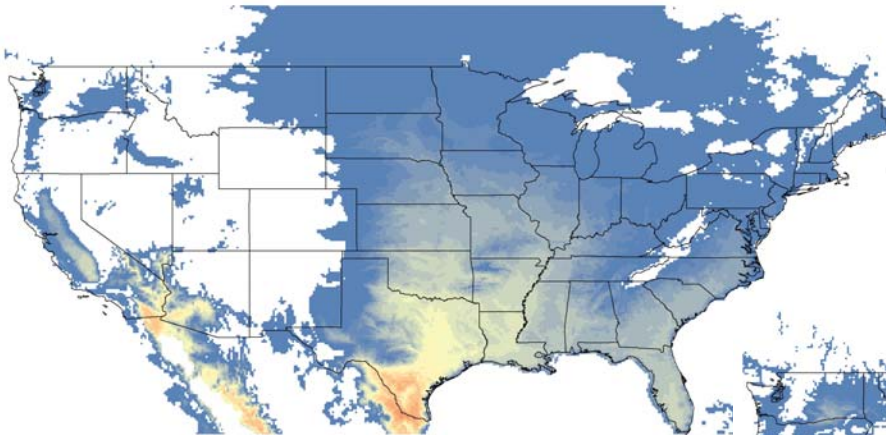
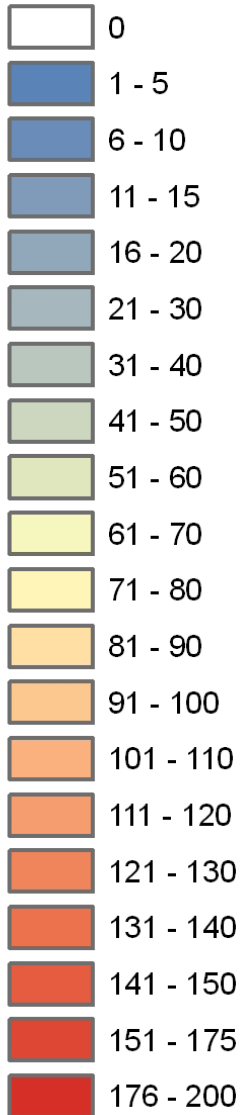


2100 A2 climate

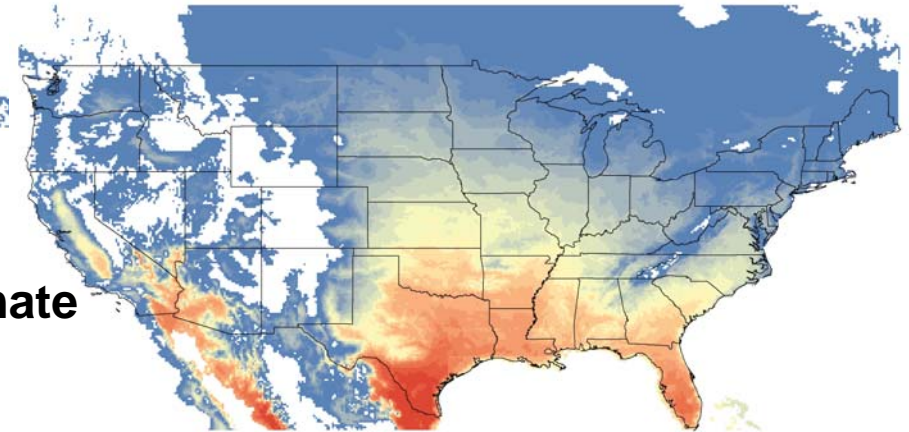
Example of current and future climates

Mean annual number of days, daily maximum Heat Index > 100 °F

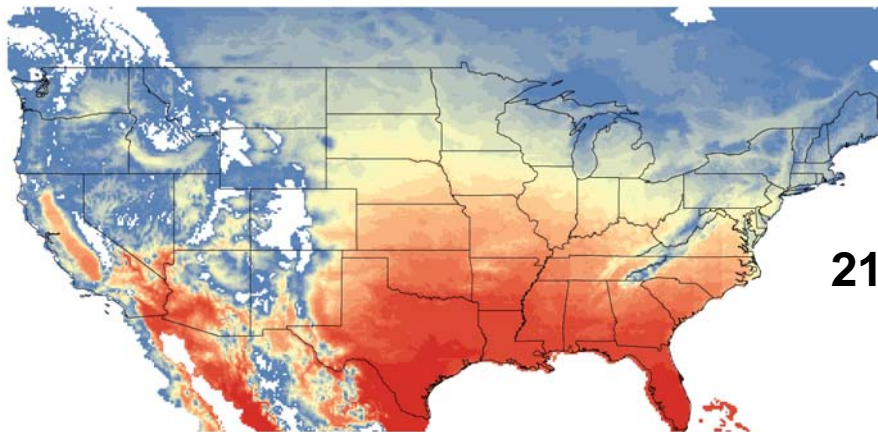
Annual days



1991-2010 NLDAS data



2050 A2 climate



2100 A2 climate

Conclusions and future work

Conclusions:

- We have combined information about future climate from GCMs (A2 scenario) with representations of excessive heat at high spatial and temporal resolutions from meteorological re-analysis to create scenarios of future heat over the U.S.
- Multi-model, multi-ensemble means of GCMs indicate increases in both temperature and specific humidity over the U.S.
- Consequently, excessive heat, as measured by three metrics, is expected to increase in frequency and magnitude.

Future work:

- Repeat analysis for A1B scenario
- Average results to the county level
- Evaluate potential impact on county-level heat-related mortality