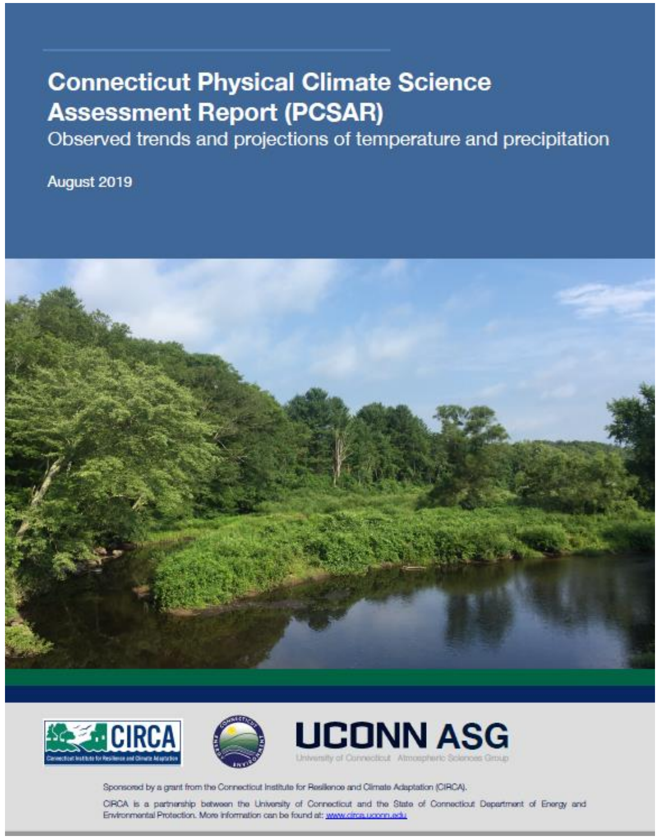
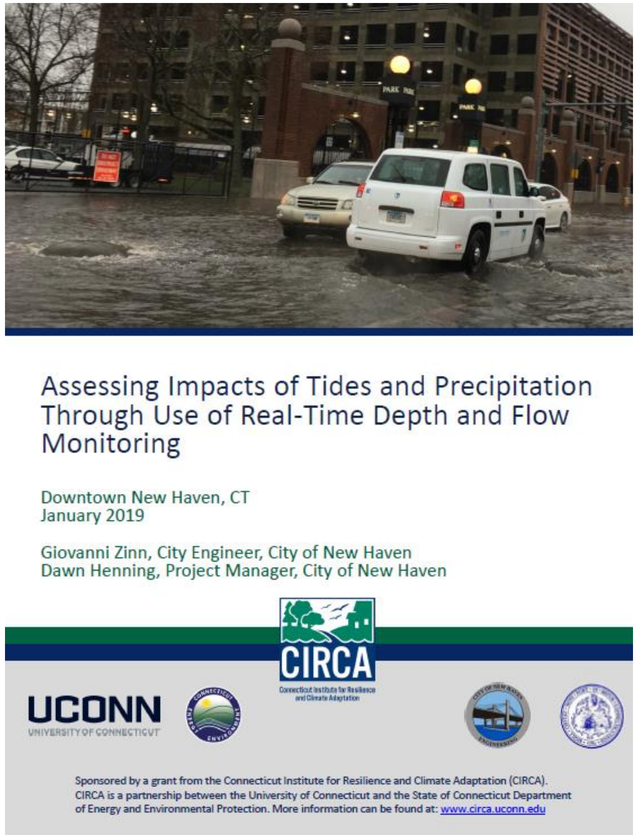




Connecticut Climate Report Webinar:
Precipitation Projections and a New Haven Case Study

September 27, 2019

UCONN

CIRCA
Connecticut Institute for Resilience and Climate Adaptation

CONNECTICUT ENERGY ENVIRONMENT

UConn Atmospheric Science Group (ASG):

Anji Seth (Lead for temperature, ASG Chair, Dept. of Geography)

Guiling Wang (Lead for precipitation, Dept. of Civil and Environmental Engineering)

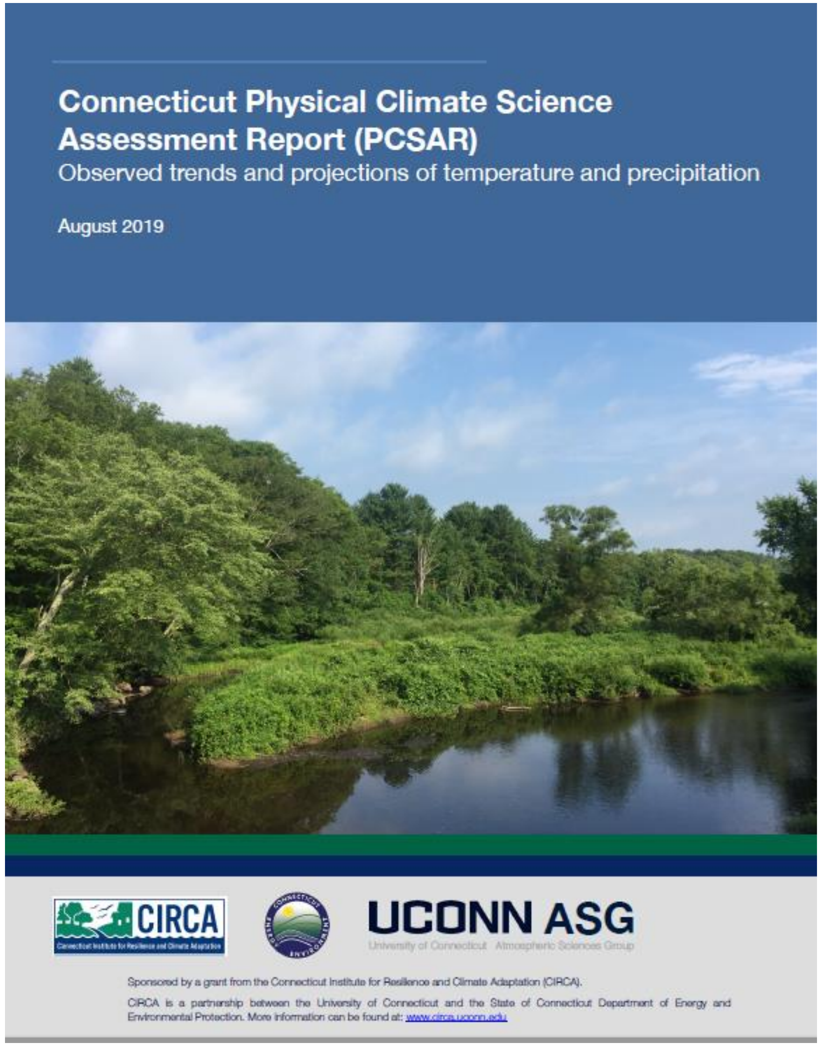
Christine Kirchhoff (Dept. of Civil and Environmental Engineering)

Scott Stephenson (Dept. of Geography)

Kelly Lombardo (Dept. of Marine Science)

Richard Anyah (Dept. of Natural Resources and Environment)

Junya Wu (Dept. of Geography)



Future Projection of Precipitation Characteristics in Connecticut:

Results from the *Connecticut Physical Climate Science Assessment Report*

September 27, 2019

Dr. Guiling Wang (guiling.wang@uconn.edu)
https://hydroclimatology.uconn.edu
Department of Civil & Environmental Engineering and
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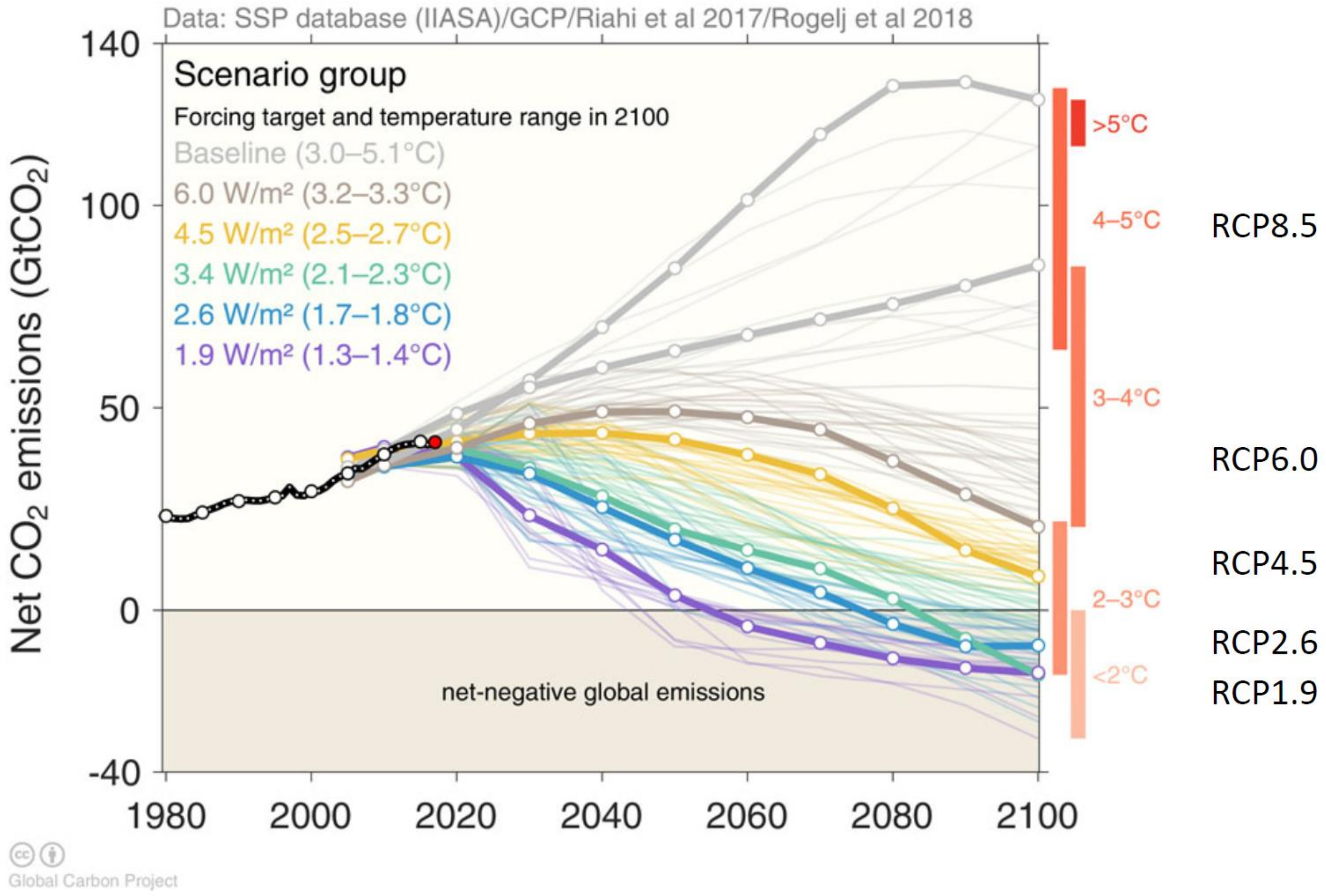
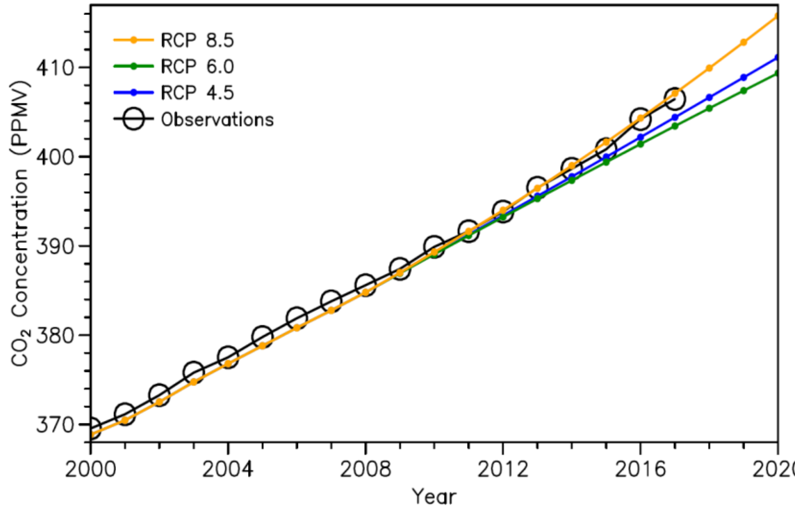
University of Connecticut

Assessing Future Changes in Connecticut

- Spatially distributed assessment for CT
  - With regional plots to show spatial context and large scale features
- Based on fine temporal (daily) and spatial (4km) resolution data
  - MACAv2-METDATA (Abatzoglou et al., 2013), a statistically downscaled climate product for the U.S., using the *Multivariate Adaptive Constructed Analogs* method trained based on observational data METDATA
  - *Available for 20 GCMs*
- Time periods for comparison:
  - **Historical** reference: 1970-99
  - Future projections: **mid-century** (2040-69) and **late-century** (2070-99)
- Future CO_2 emission scenario – RCP8.5
  - Recent CO_2 emissions closely tracked the RCP8.5 scenario
- Eight models to account for model related uncertainties (2 from USA, 1 each from Canada, UK, France, Australia, China, Russia)
  - Chosen based on model genealogy, performance in the region of interest, regional and global climate sensitivity

CO_2 Emissions, Representative Concentration Pathways (RCPs), and Warming





Our analysis emphasizes high emissions. Reduced emissions will yield smaller changes.

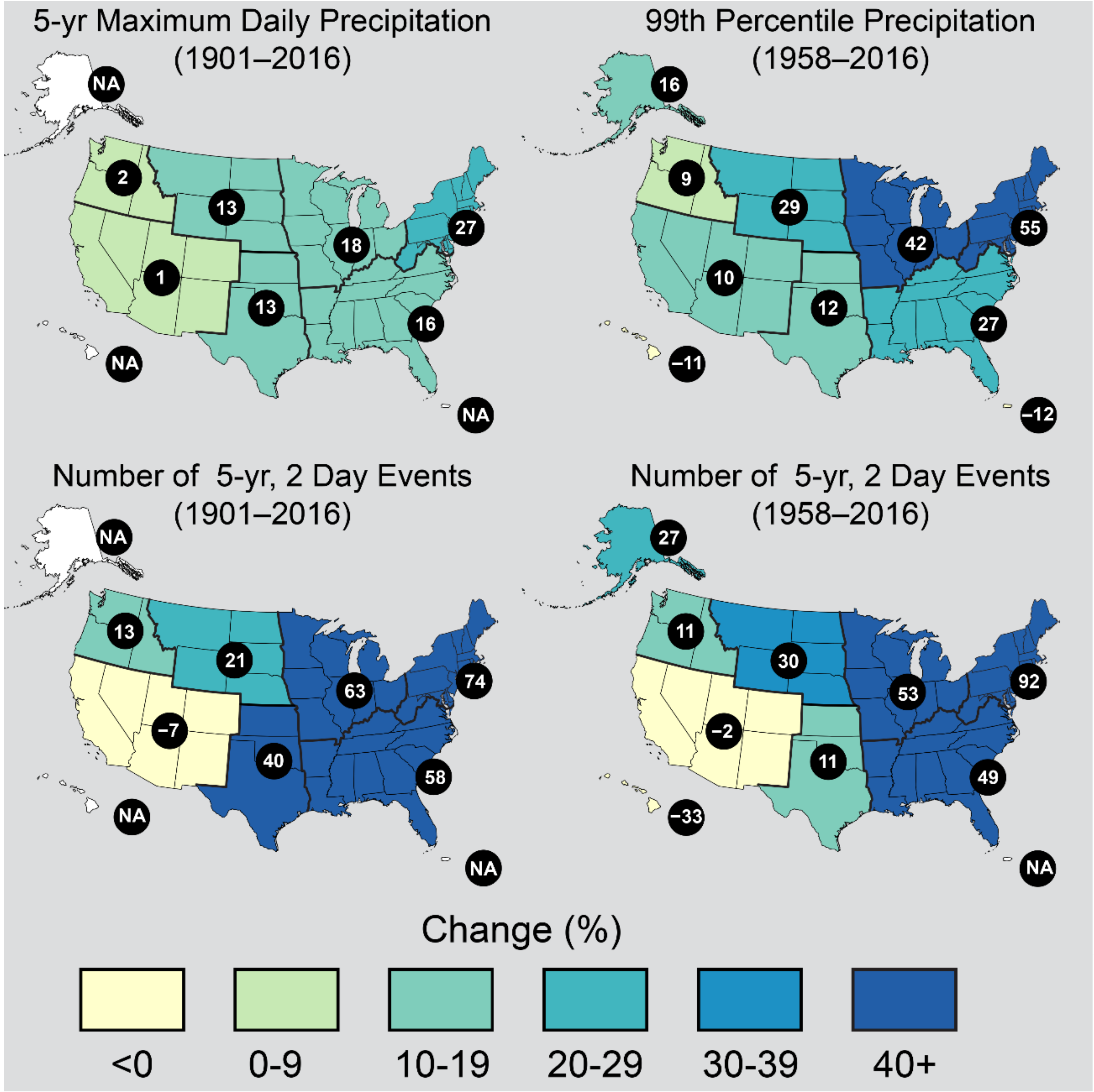
Theoretically,

- Warming-induced acceleration of evapotranspiration (ET) exacerbates aridity, increasing drought risk
- Warmer air holds more moisture, increasing precipitation intensity & extremes therefore flood risk

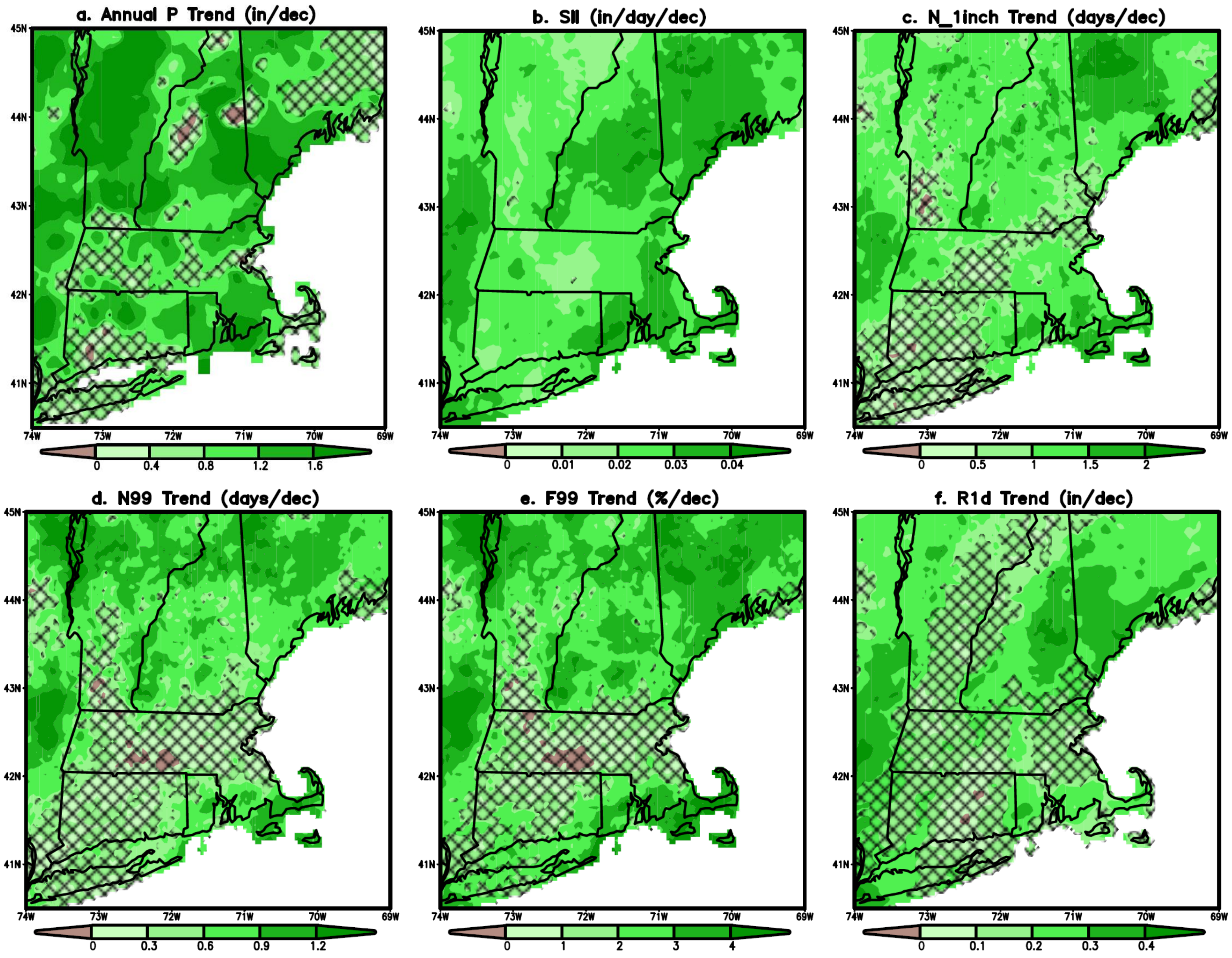
Observationally,

Northeast Leads the Way

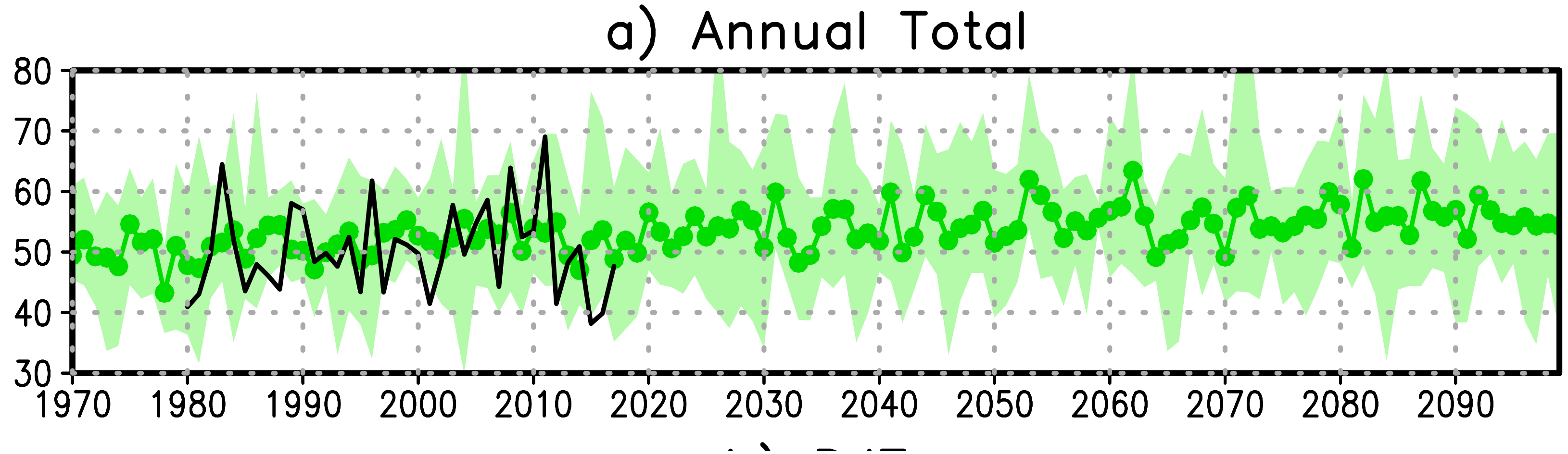
towards more frequent and more intense heavy precipitation events (4th National Climate Assessment, Easterling et al., 2017)



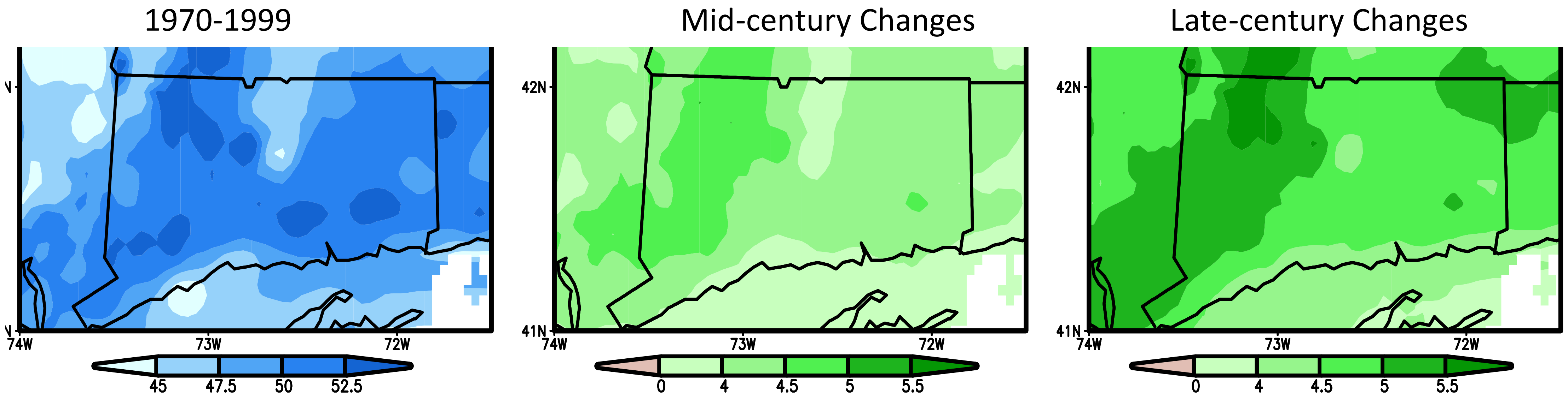
Heavy Precipitation on the Rise: Past observed trend



Connecticut Precipitation on the Rise: Future Projections

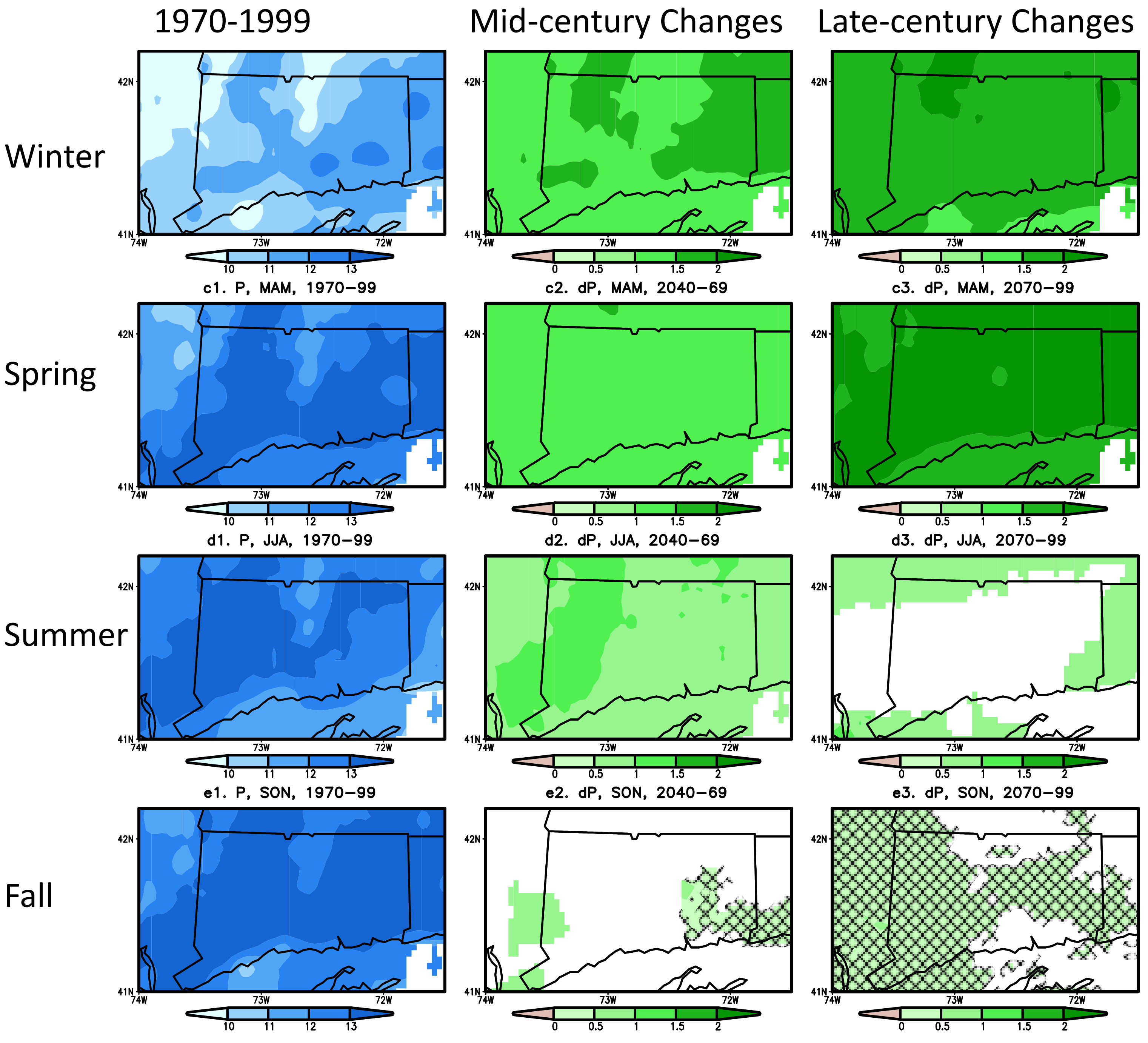


	1970-99	2040-69 Changes	2070-99 Changes
Annual	**50.9**	**4.3 (9%)**	**4.9 (10%)**
Winter	11.1	1.5 (13%)	1.8 (16%)
Spring	13.1	1.3 (10%)	2.2 (17%)
Summer	13.0	1.0 (8%)	N/A
Fall	13.6	N/A	N/A



- Significant increase of annual precipitation, +4 inches (8% mid) and +5 inches (10% late)

CT precipitation in different seasons

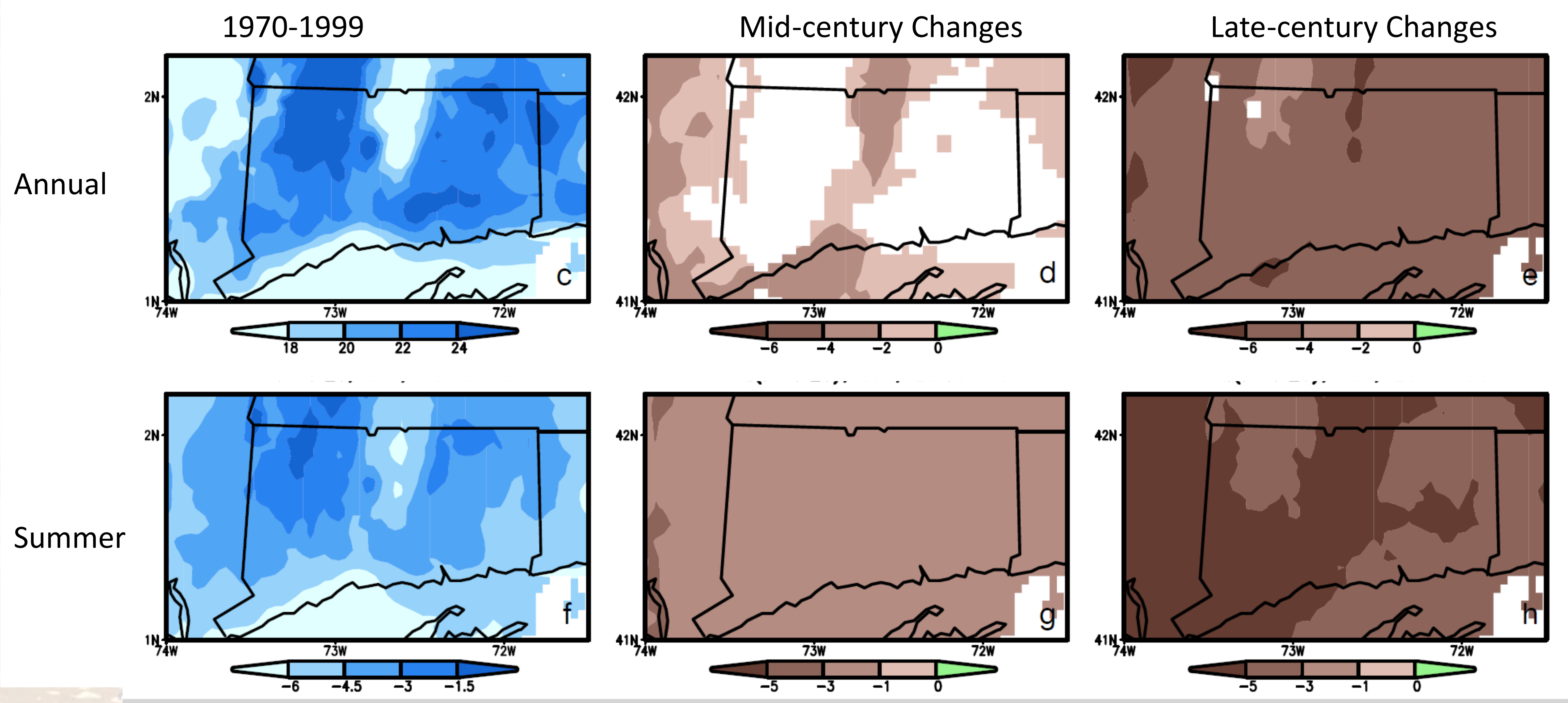


- Significant increase projected for winter and spring
- Inconclusive changes in summer and fall

Blank areas over land: lack of model consensus

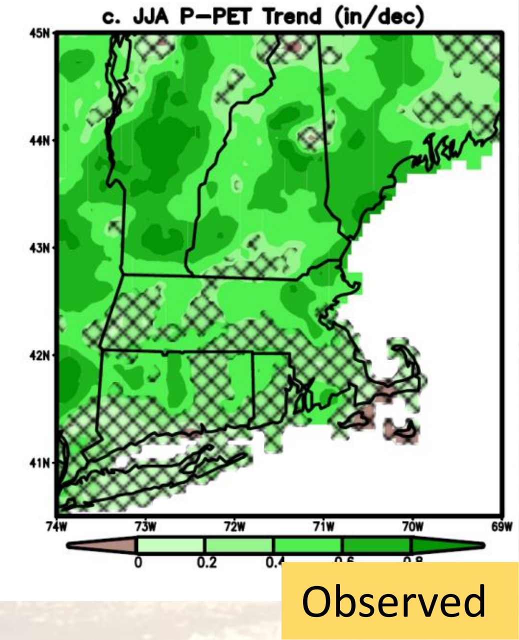
Hatching: Lack of statistical significance in the magnitude of projected changes

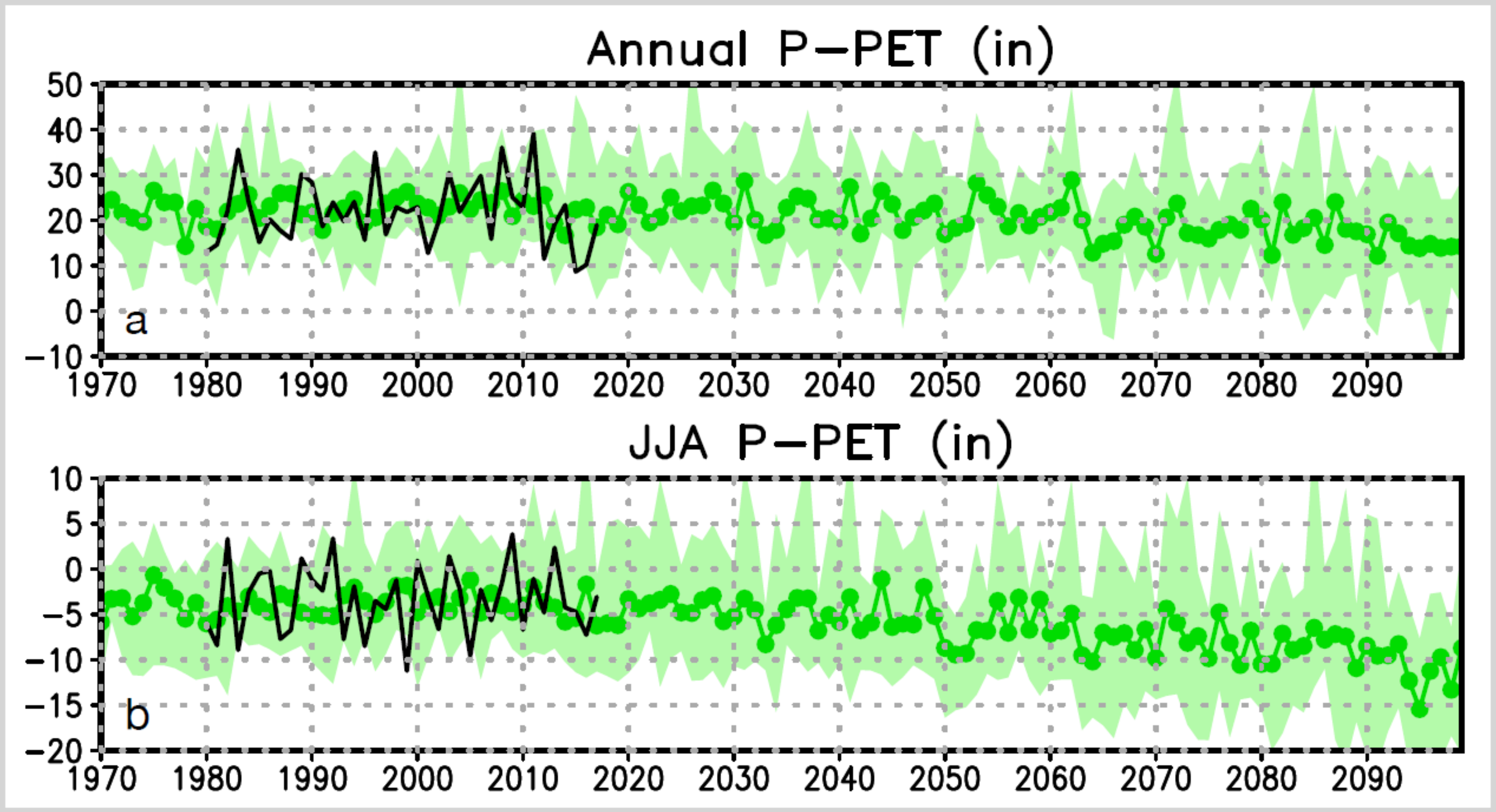
Lower Potential Water Availability (Drought Index, P – PET)



- Decrease of potential water availability
- Largest decrease projected for summer

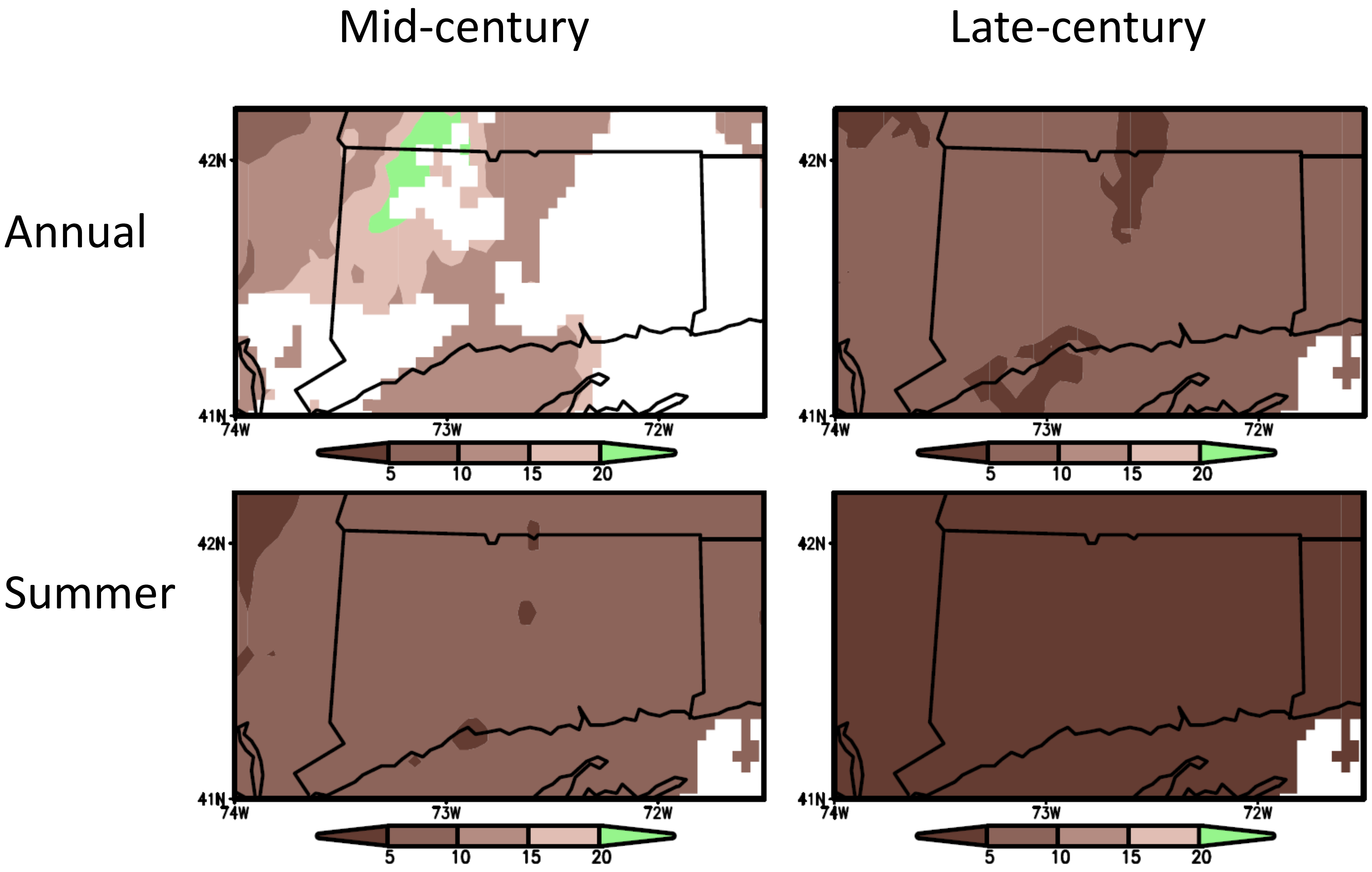
Lower Potential Water Availability (Drought Index, P – PET): CT Average

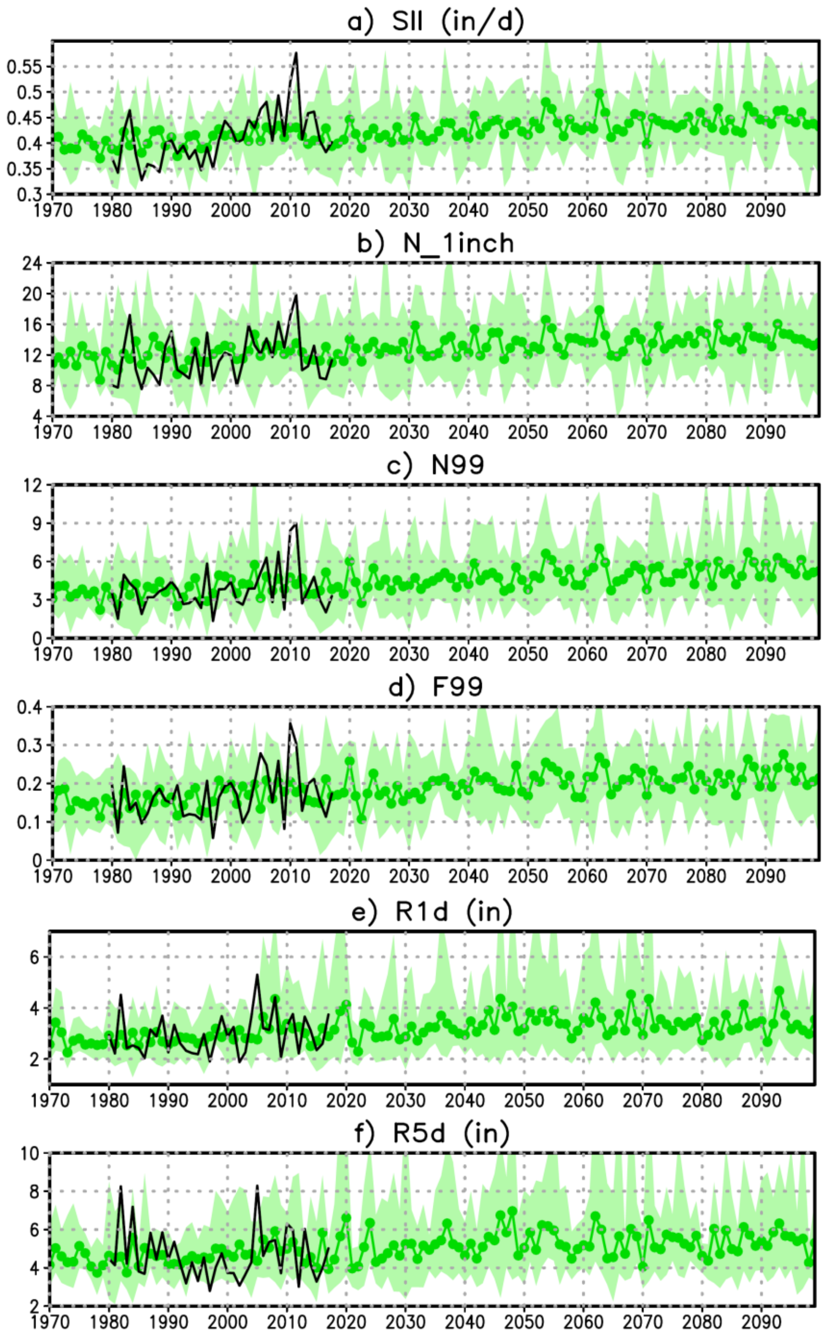




- Decrease of potential water availability (increase of drought severity), especially in summer
- Past observed trend is not indicative of future changes (yet!)

New Recurrence Interval (T, in years):
More Frequent Occurrence of Previously 1-in-20-years Drought





CT Heavy Precipitation On the Rise

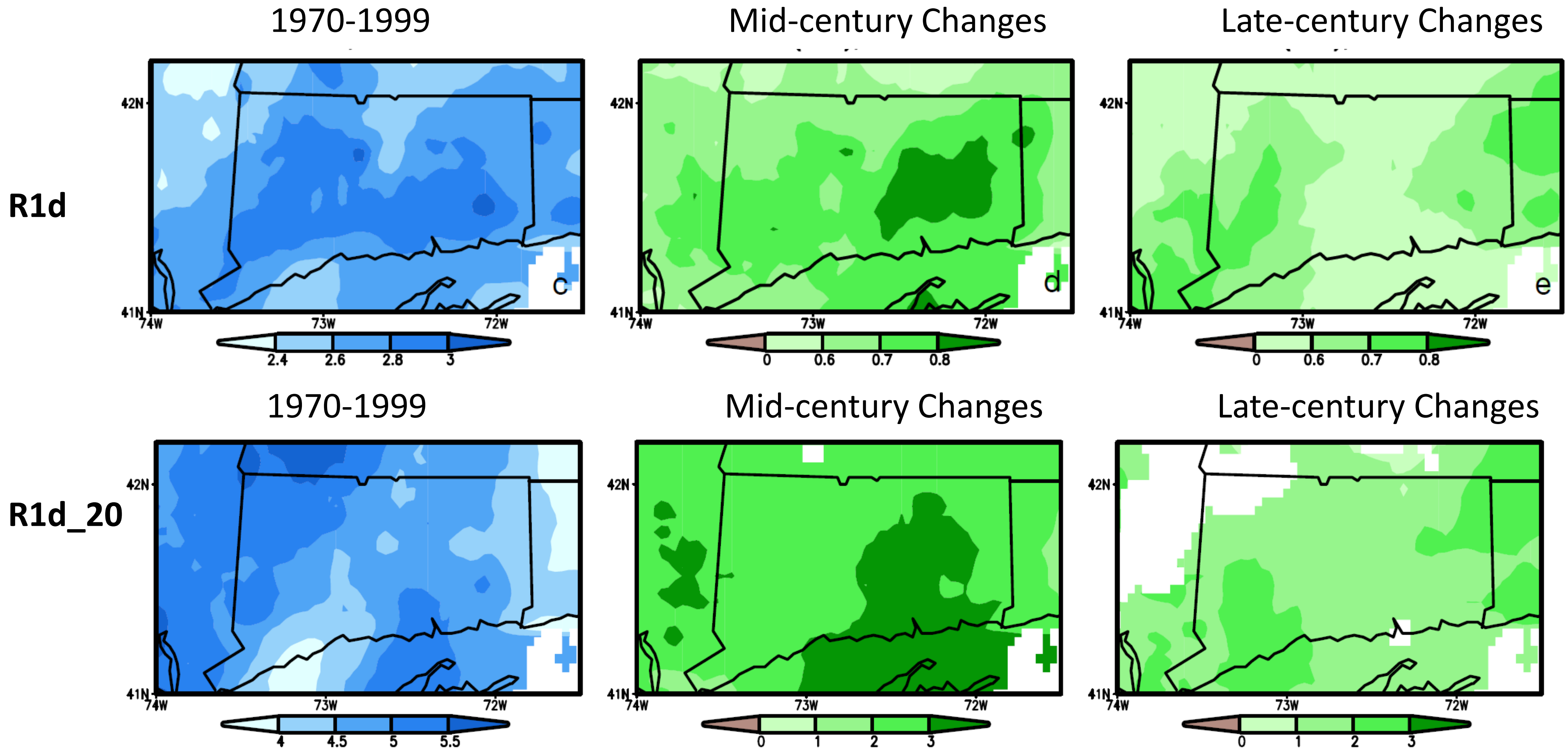
All precipitation indices examined show an increase of precipitation intensity and extremes:

- **SII:** simple intensity index (average rain intensity)
- **N_1inch:** Number of days with >1 inch of precipitation
- **N_{99}:** Number of days with heavy precipitation (>P_{99})
- **F_{99}:** Fractional of annual precipitation accounted for by heavy precipitation events
- **R1d:** annual maximum 1-day precipitation
- **R5d:** annual maximum 5-day precipitation

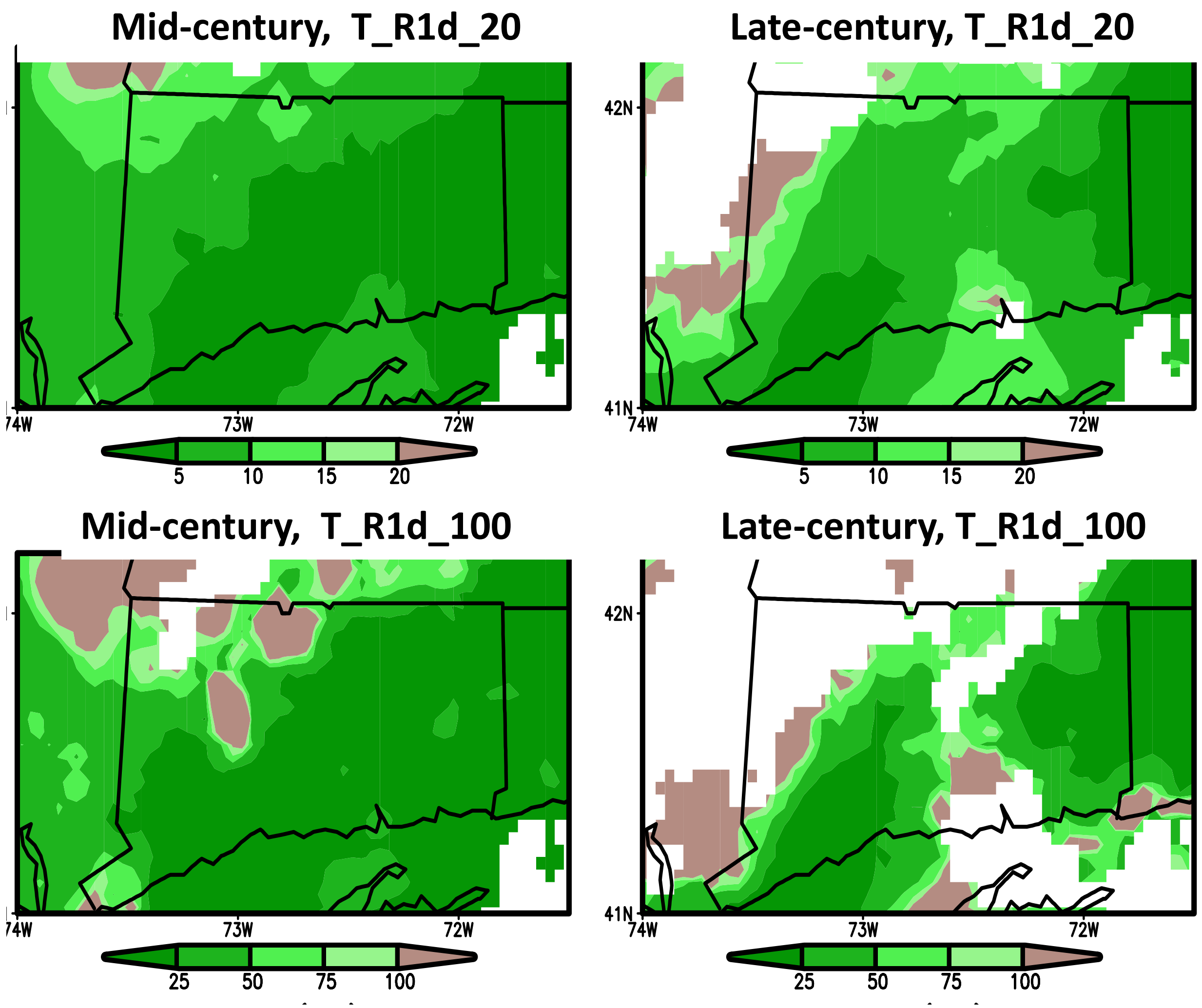
Projected Changes of Precipitation Indices Averaged over CT

Variables	1970-99 Reference	Mid-century Changes	Late-century Changes
SII (in/days)	0.4±0.06	0.036 ± 0.02	0.04±0.03
N_1inch	11.7±0.3	1.9±1.0	2.3±1.7
N99	3.6±0.0	1.3±0.6	1.6±1.0
F99 (%)	15.4±0.5	5.6±1.8	6.0±2.9
R1d (in)	2.8± 0.1	0.7± 0.2	0.6± 0.2
R5d (in)	4.5± 0.3	0.9± 0.4	0.8± 0.3

Projected Changes of the Annual Maximum 1-day Precipitation: 30-year average (R1d) and 1-in-20-years extreme (R1d_20)



New Recurrence Interval of previously 1-in-20-years and 1-in-100-years events for 1-day precipitation



More frequent occurrence of previously rare heavy precipitation events over most of the state:

- 20 years → less than 10 years
- 100 years → less than 50 years

Blank areas: The 8 models split at 4-vs-4 or 5-vs-3 on how the frequency of extreme events would change

Projected changes for late century are smaller than for mid-century …

- Decadal Variability
- Larger uncertainty further into the future
- Larger uncertainty for rarer events
- Deficiency of the statistical downscaling approach in dealing with late-century precipitation events that have no historical analog

Projections for Connecticut

- Significant increase of annual precipitation, +4 inches (8%) by mid-century and +5 inches (10%) by late century, with large increases projected for winter and spring.
- Significant decrease of potential water availability (as represented by P-PET) during summer, suggesting significantly higher drought risk.
- Significant increases of the average precipitation intensity and the fraction of annual amount accounted for by heavy precipitation events
- Significant increase in both the intensity of extreme precipitation and the frequency of previously rare extreme precipitation events, suggesting significantly higher flood risk.