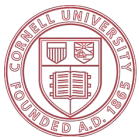# New Climate Projections from CMIP6

Art DeGaetano

Professor, Dept of Earth and Atmospheric Science, Cornell Univ.
Director, NOAA Northeast Regional Climate Center
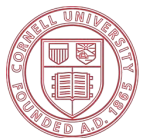
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# LOCA

| Climate Models | Affiliated Institutions | Original Spatial Resolution |
| --- | --- | --- |
| ACCESS1-0, ACCESS1-3 | CSIRO, Bureau of Meteorology (Australia) | ~250 km |
| CCSM4 | National Center for Atmospheric Research (USA) | ~110 km |
| CESM1-BGC, CESM1-CAM5 | National Center for Atmospheric Research (USA) | Various |
| CMCC-CM, CMCC-CMS | CMCC Foundation (Italy) | ~180 km |
| CNRM-CM5 | CNRM (France) | ~250 km |
| CSIRO-Mk3-6-0 | CSIRO (Australia) | ~200 km |
| CanESM2 | Canadian Centre for Climate Modelling and Analysis (Canada) | ~200 km |
| EC-EARTH | European Consortium | ~150 km |
| FGOALS-g2 | Institute of Atmospheric Physics, Chinese Academy of Sciences (China) | ~150 km |
| GFDL-CM3, GFDL-ESM2G, GFDL-ESM2M | Geophysical Fluid Dynamics Laboratory (USA) | ~200 km |
| GISS-E2-R | Goddard Institute for Space Studies (USA) | ~200 km |
| HadGEM2-AO, HadGEM2-CC, HadGEM2-ES | UK Met Office (United Kingdom) | ~150 km |
| IPSL-CM5A-LR, IPSL-CM5A-MR | Institut Pierre-Simon Laplace (France) | ~250 km |
| MIROC-ESM, MIROC-ESM-CHEM, MIROC5 | Multiple Japanese Institutions | ~150 km |
| MPI-ESM-LR, MPI-ESM-MR | Max Planck Institute for Meteorology (Germany) | ~200 km |
| MRI-CGCM3 | Meteorological Research Institute (Japan) | ~200 km |
| NorESM1-M | Norwegian Climate Centre (Norway) | ~140 km |
| bcc-csm1-1, bcc-csm1-1-m | Beijing Climate Center (China) | ~250 km |
| inmcm4 | Institute for Numerical Mathematics (Russia) | ~200 km |

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# LOCA2

27 Models

99 model-experiments

      ssp 245

      ssp370

      ssp585

329 model-experiment-ensembles

26,026 total model years

| Climate Model | Affiliated Institution | Original Spatial Resolution |
|---|---|---|
| ACCESS-CM2, ACCESS-ESM1-5 | CSIRO, Bureau of Meteorology (Australia) | ~250 km |
| AWI-CM-1-1-MR | Alfred Wegener Institute (Germany) | ~100 km |
| BCC-CSM2-MR | Beijing Climate Center (China) | ~100 km |
| CanESM5 | Canadian Centre for Climate Modelling and Analysis | ~200 km |
| CNRM-CM6-1, CNRM-ESM2-1 | National Centre for Meteorological Research (France) | ~250 km |
| EC-Earth3-Veg, EC-Earth3 | Multiple European Institutions | ~80 km |
| FGOALS-g3 | Institute of Atmospheric Physics, Chinese Academy of Sciences (China) | ~100 km |
| GFDL-ESM4 | Geophysical Fluid Dynamics Laboratory (USA) | ~100 km |
| INM-CM4-8, INM-CM5-0 | Institute for Numerical Mathematics (Russia) | ~140 km/~200 km |
| IPSL-CM6A-LR | Institut Pierre-Simon Laplace (France) | ~250 km |
| KACE-1-0-G | Korea Institute of Atmospheric Prediction Systems (South Korea) | ~100 km |
| MIROC6 | Multiple Japanese Institutions | ~100 km |
| MPI-ESM1-2-HR, MPI-ESM1-2-LR | Max Planck Institute for Meteorology (Germany) | ~60 km/~200 km |
| MRI-ESM2-0 | Meteorological Research Institute (Japan) | ~130 km |
| NorESM2-LM, NorESM2-MM | Norwegian Climate Centre (Norway) | ~100 km/~60 km |

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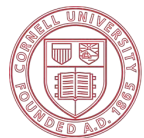
# Who does climate modelling around the world?

# CMIP6 vs CMIP5



CO2 emissions in comparable CMIP5 and CMIP6 scenarios
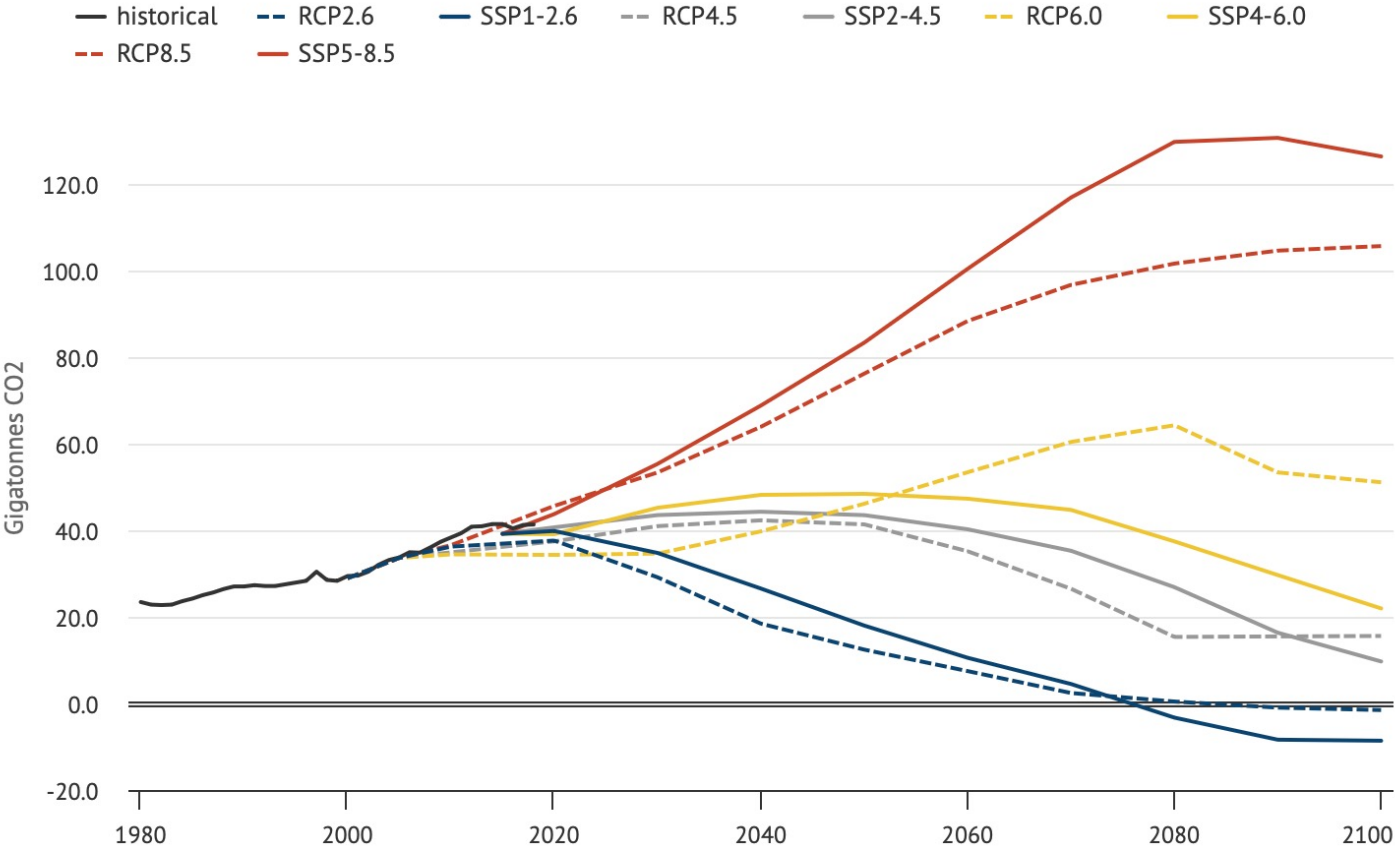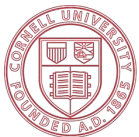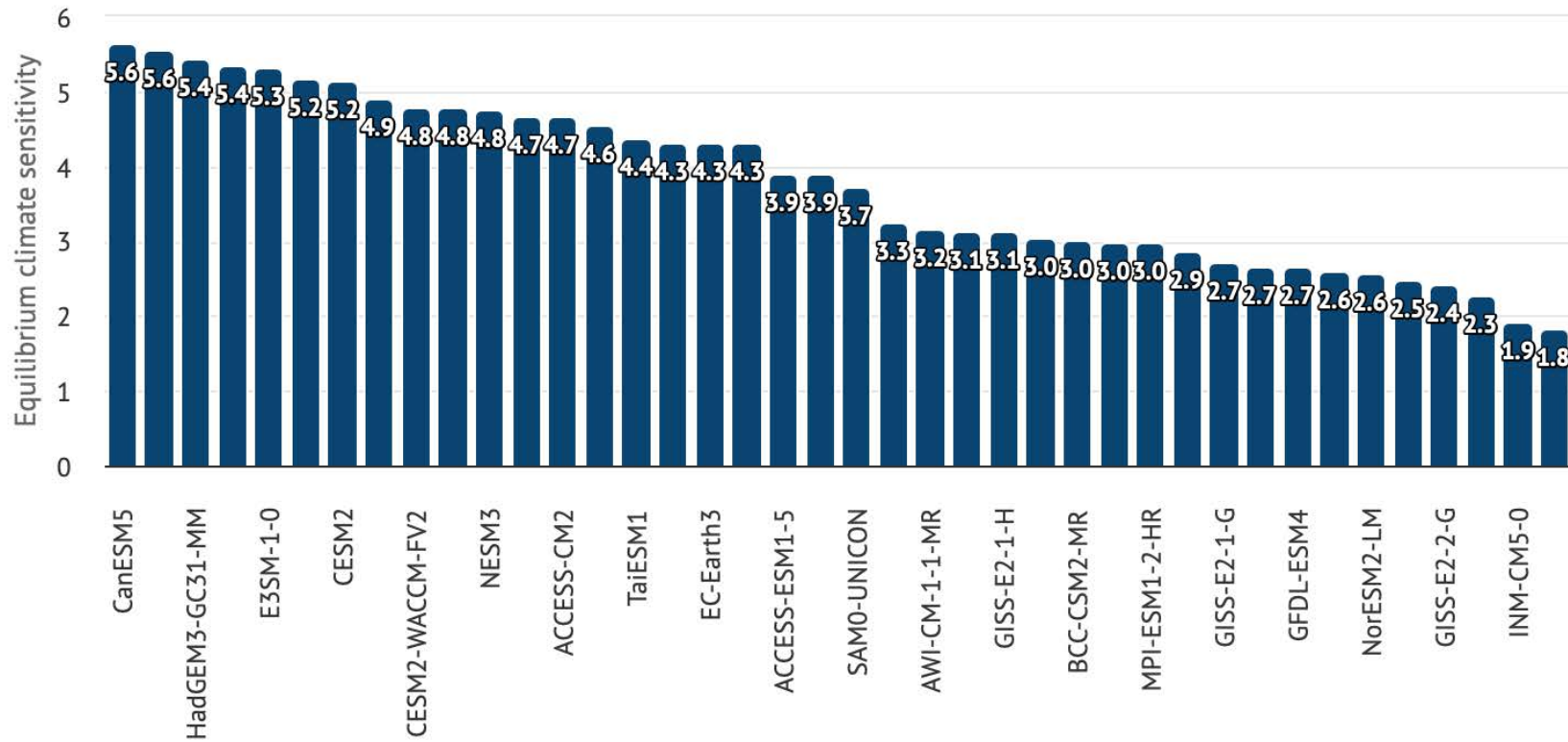
# CMIP6 vs CMIP5



**CMIP6 models show a wider range of climate sensitivity**
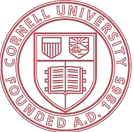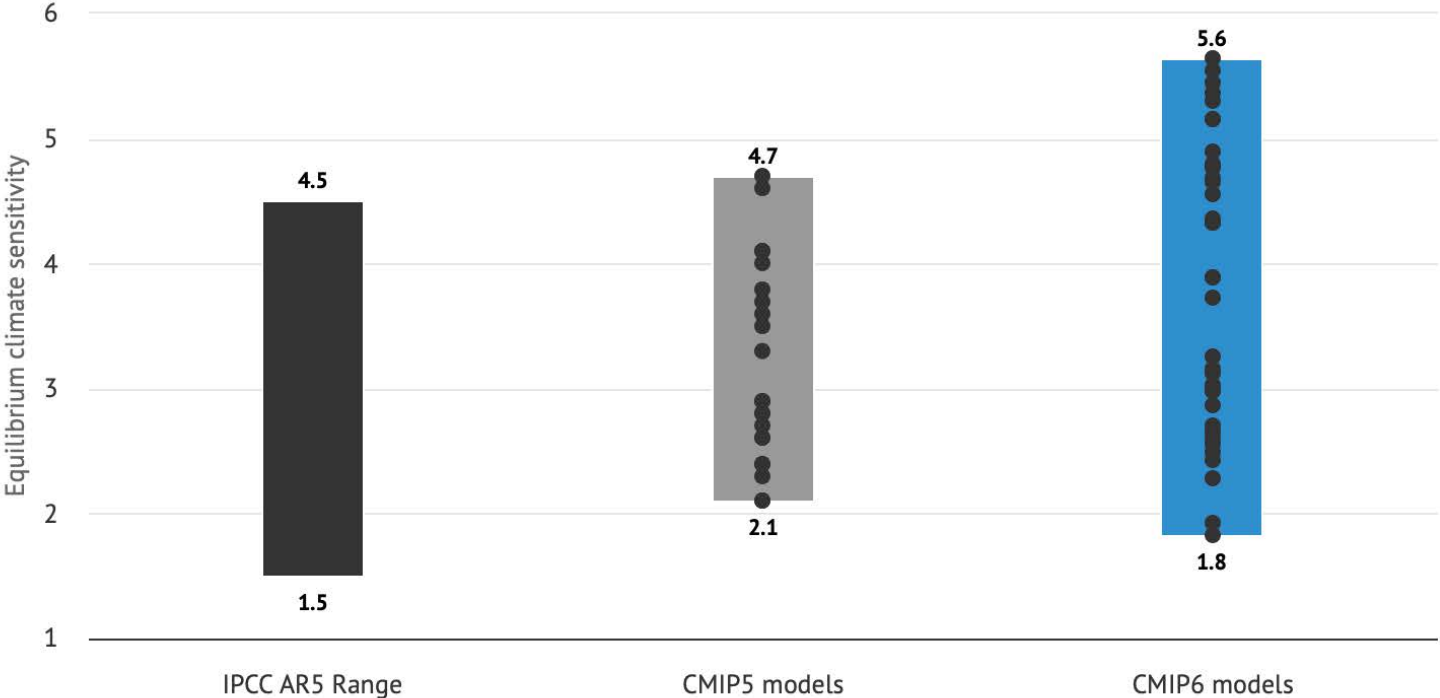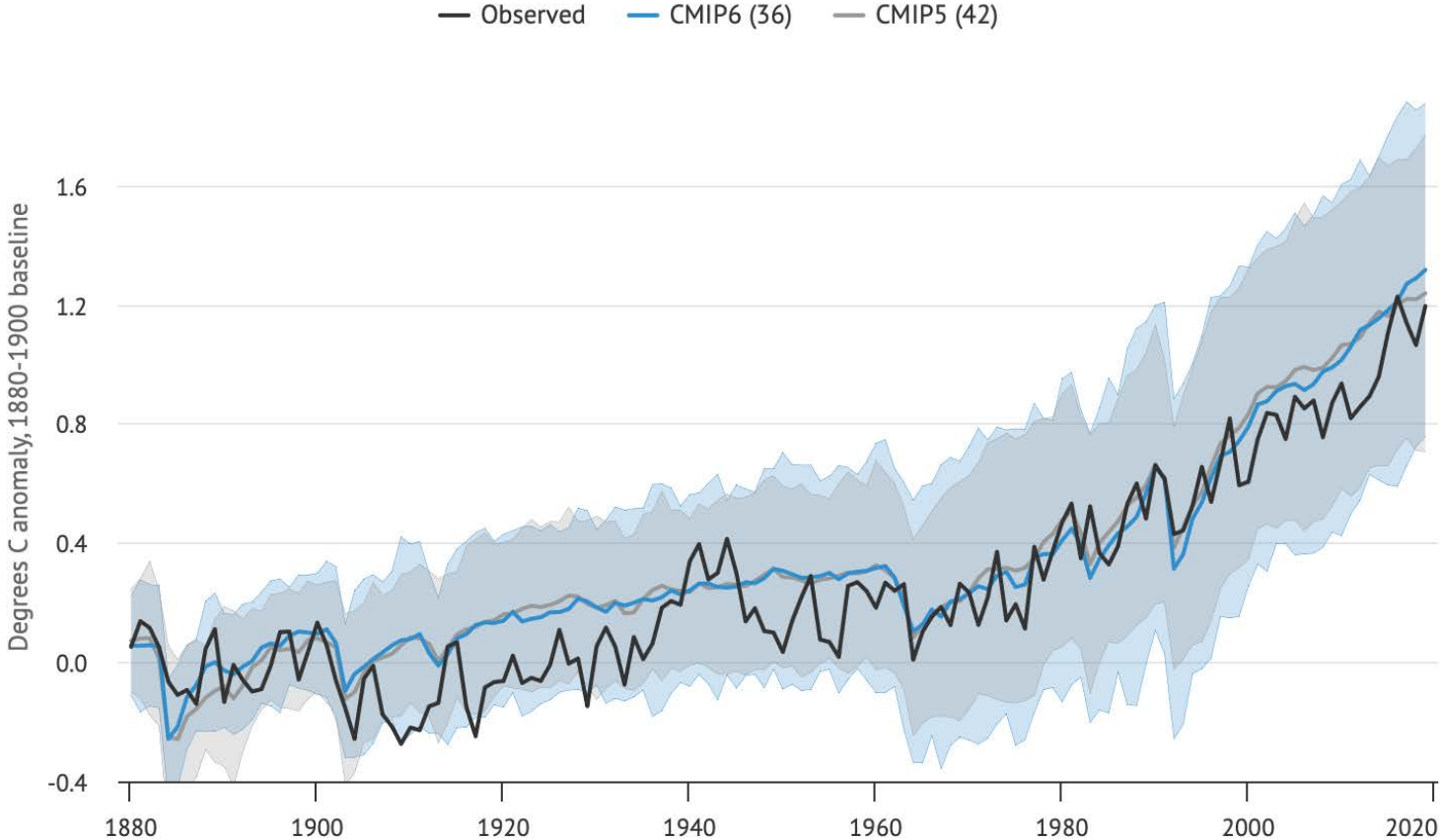
# CMIP6 vs CMIP5



Climate sensitivity in CMIP6 models

# CMIP6 vs CMIP5

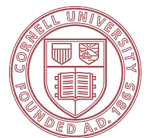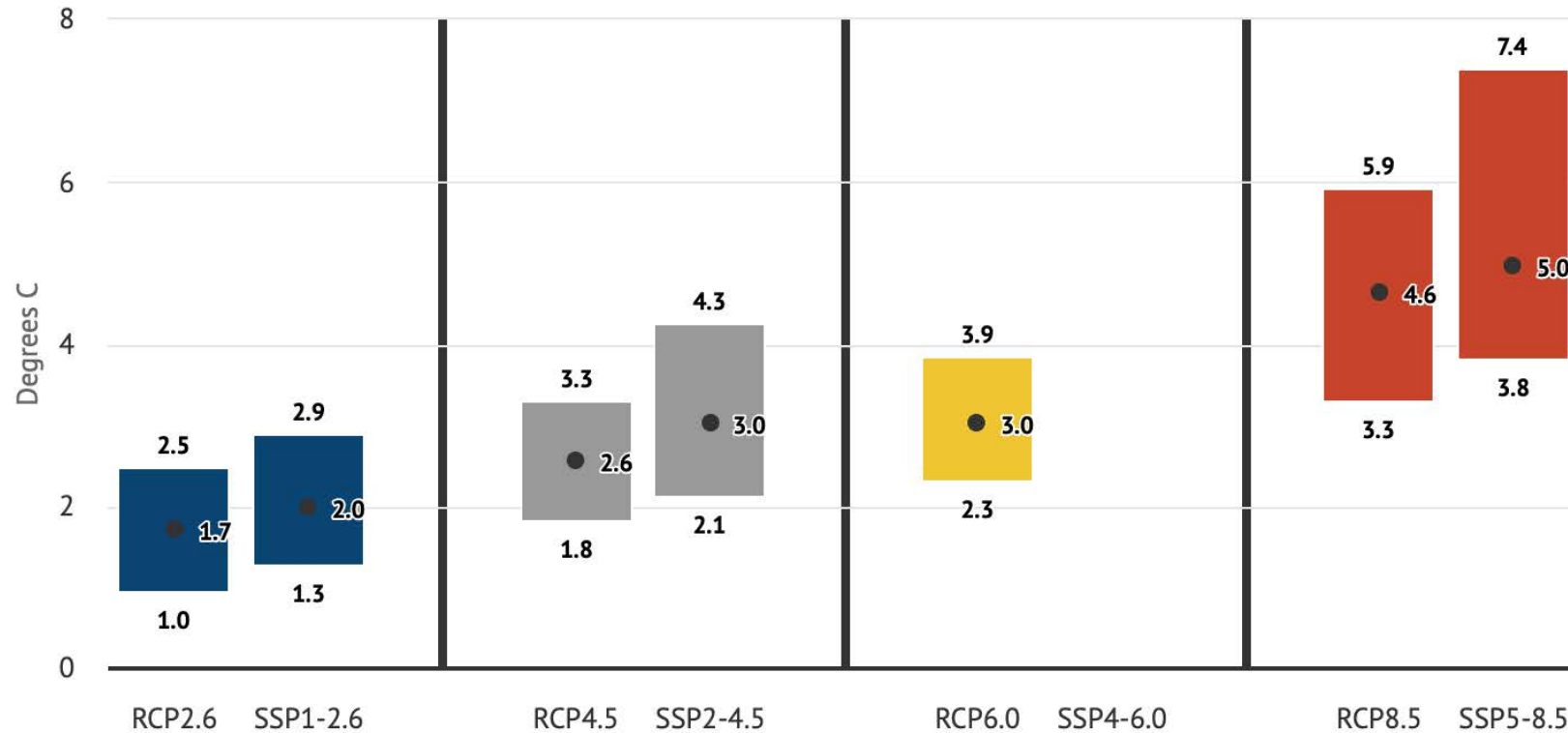**Global surface temperatures 1880-2019: CMIP5, CMIP6 and observations**

For currently available CMIP6 runs. Observational data from NASA GISTEMP.

— Observed  — CMIP6 (36)  — CMIP5 (42)

# CMIP6 vs CMIP5



**Comparing CMIP5 and CMIP6 scenarios**

For currently available runs, from 1880-1900 to 2090-2100.

# LOCA2 vs LOCA

Enhancements in LOCA2 improve the depiction of daily precip extremes

- New precipitation training data set that better represents daily precipitation extremes

- Ensemble bias correction approach that better preserves extreme events in models that have more than one ensemble member

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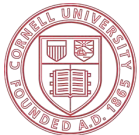
# LOCA2 in NCA5

| Model Name | BMA Weights |
|---|---|
| ACCESS-CM2 | 0.0412 |
| ACCESS-ESM1-5 | 0.0581 |
| BCC-CSM2-MR | 0.0723 |
| CanESM5 | 0.029 |
| EC-Earth3 | 0.0498 |
| FGOALS-g3 | 0.0716 |
| GFDL-ESM4 | 0.0589 |
| INM-CM4-8 | 0.0646 |
| INM-CM5-0 | 0.0649 |
| IPSL-CM6A-LR | 0.0449 |
| MIROC6 | 0.0767 |
| MPI-ESM1-2-HR | 0.0731 |
| MPI-ESM1-2-LR | 0.0755 |
| MRI-ESM2-0 | 0.073 |
| NorESM2-LM | 0.0736 |
| NorESM2-MM | 0.0727 |

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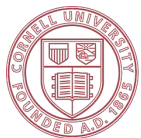
99.9th Percentile Precipitation Relative Difference (%)

(a) NClimGrid minus PRISM
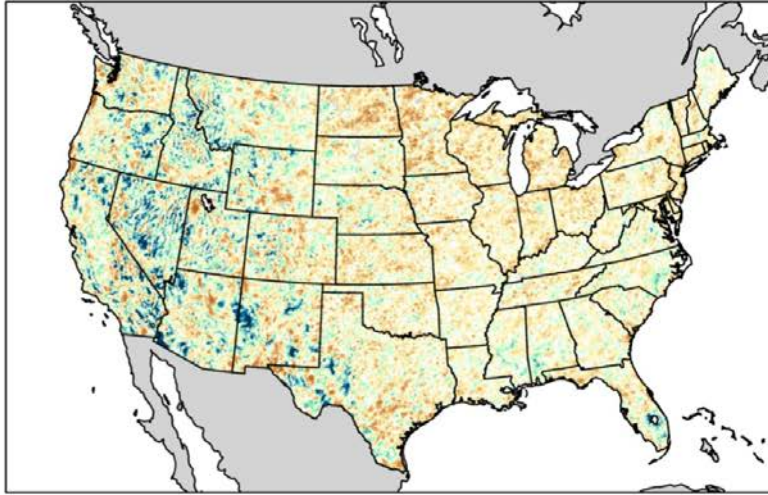
(b) Livneh minus PRISM
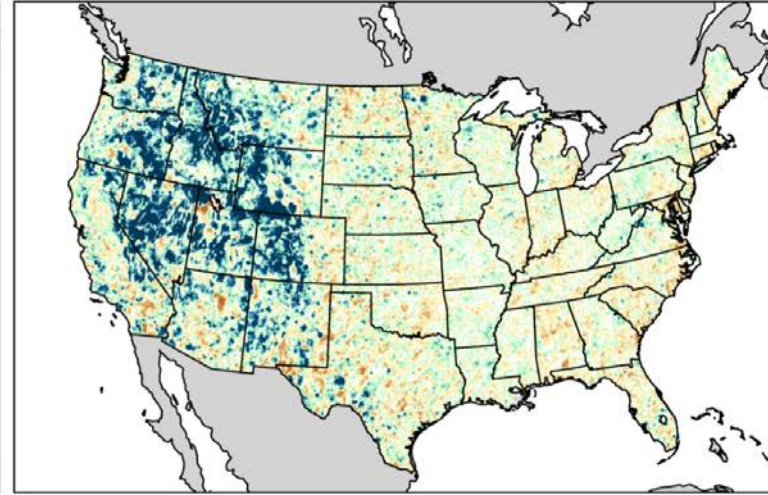
(c) STAR-ESDM minus PRISM
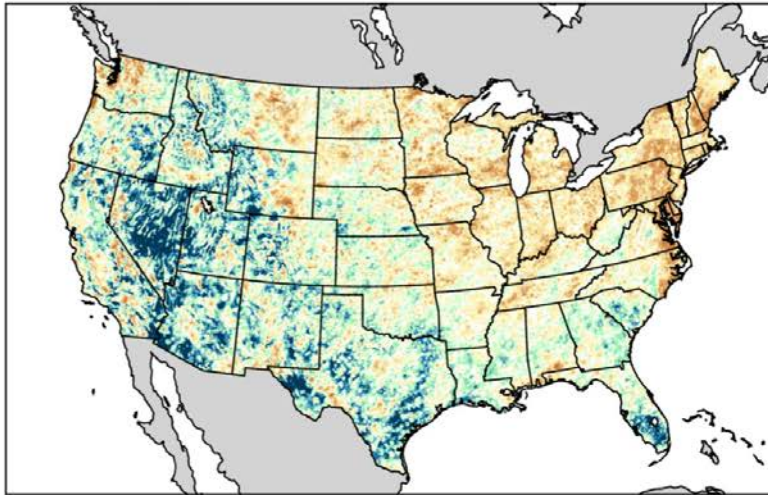
(d) LOCA2 minus PRISM

-45  -35  -25  -15  -5    5    15   25   35   45
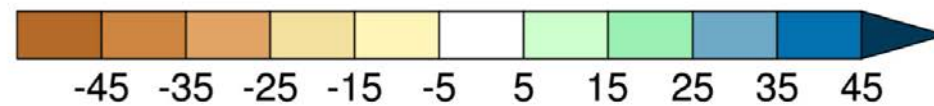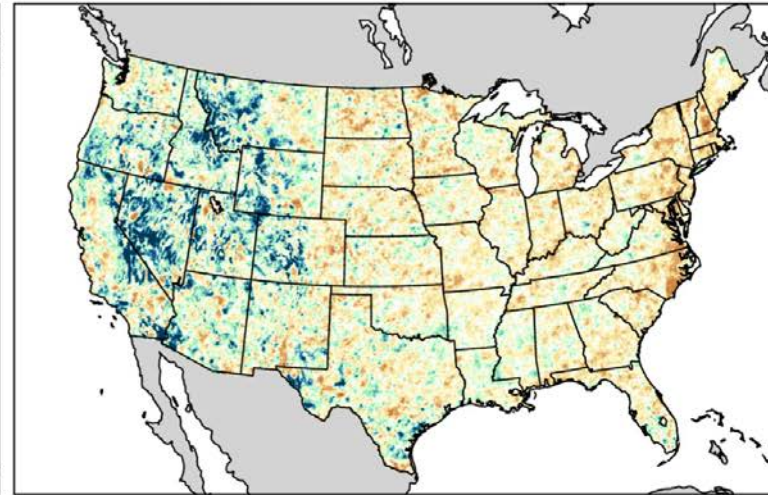
# Median Precipitation (mm/day)



(a) PRISM
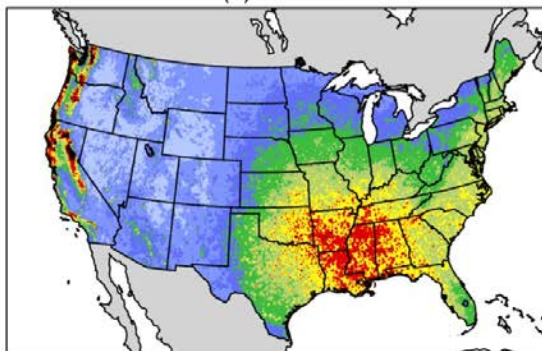
(b) NClimGrid
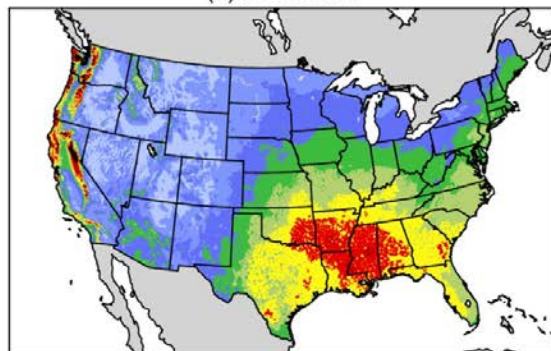
(c) Livneh-unsplit
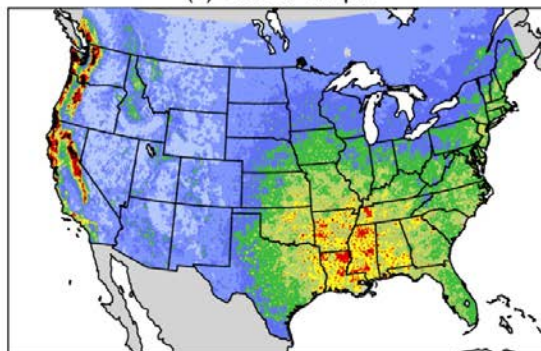
(d) STAR Ensemble Mean
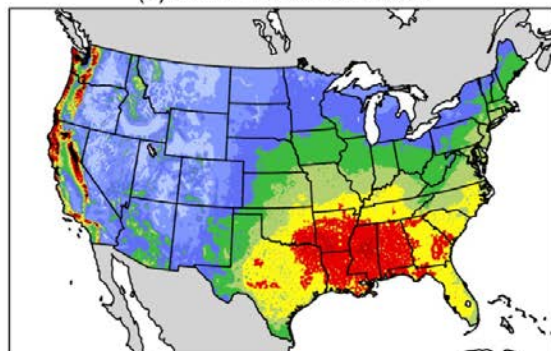
(e) LOCA2 Ensemble Mean

1 2 3 4 5 6 7 8 9 10

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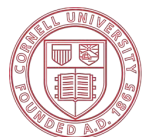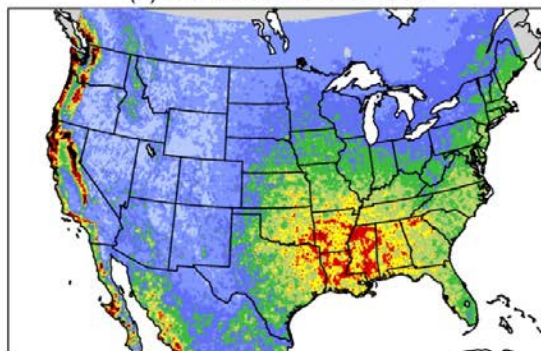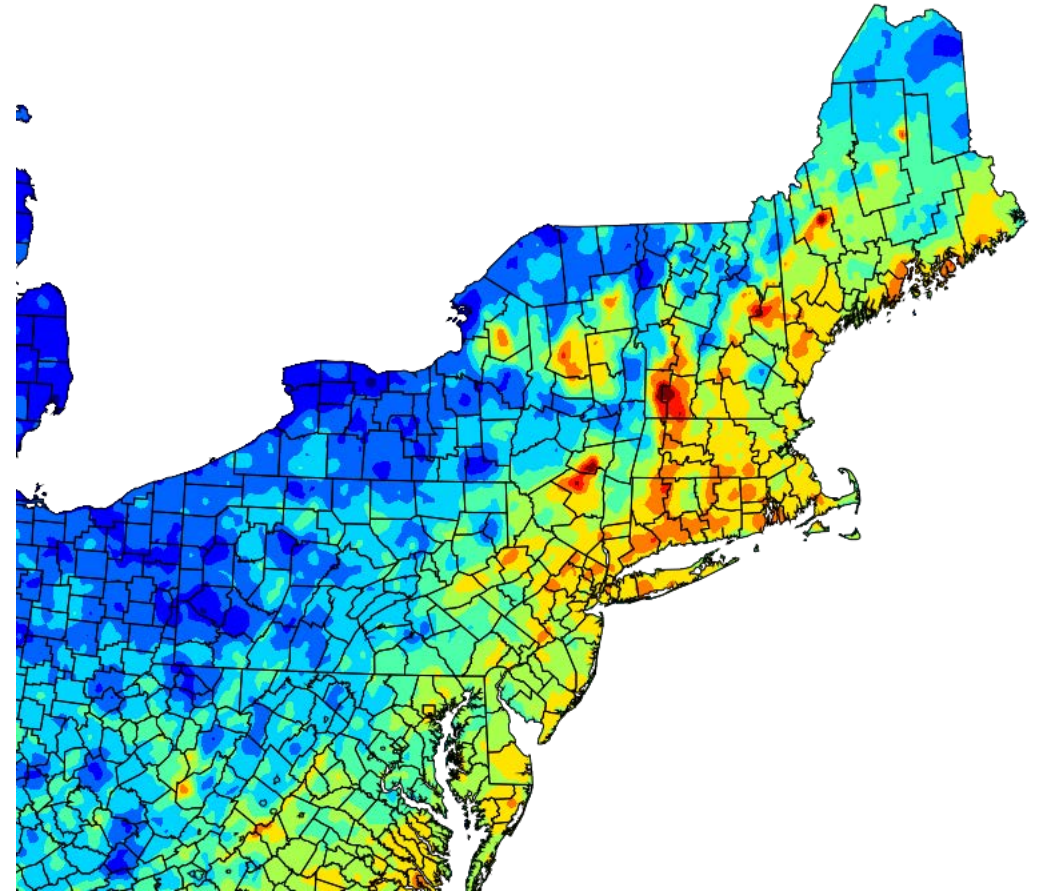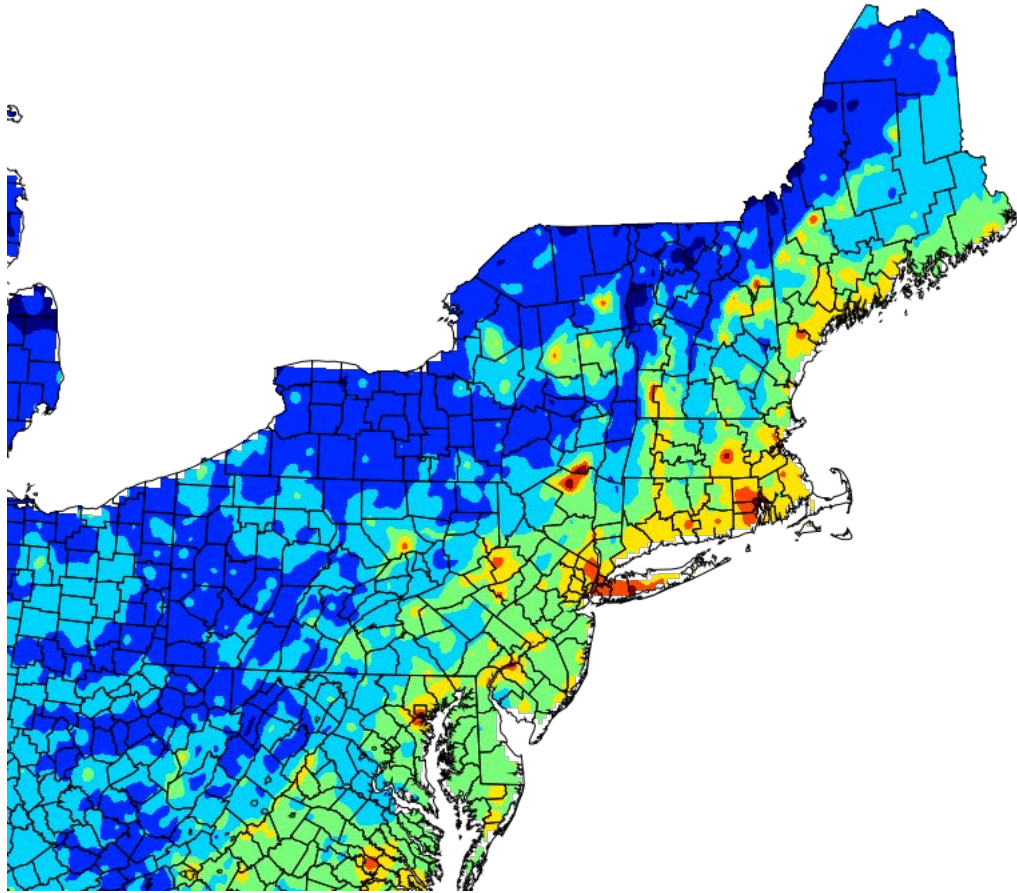
**LOCA**

**LOCA2**



**Days > 1 inch**
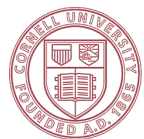
LOCA

LOCA2
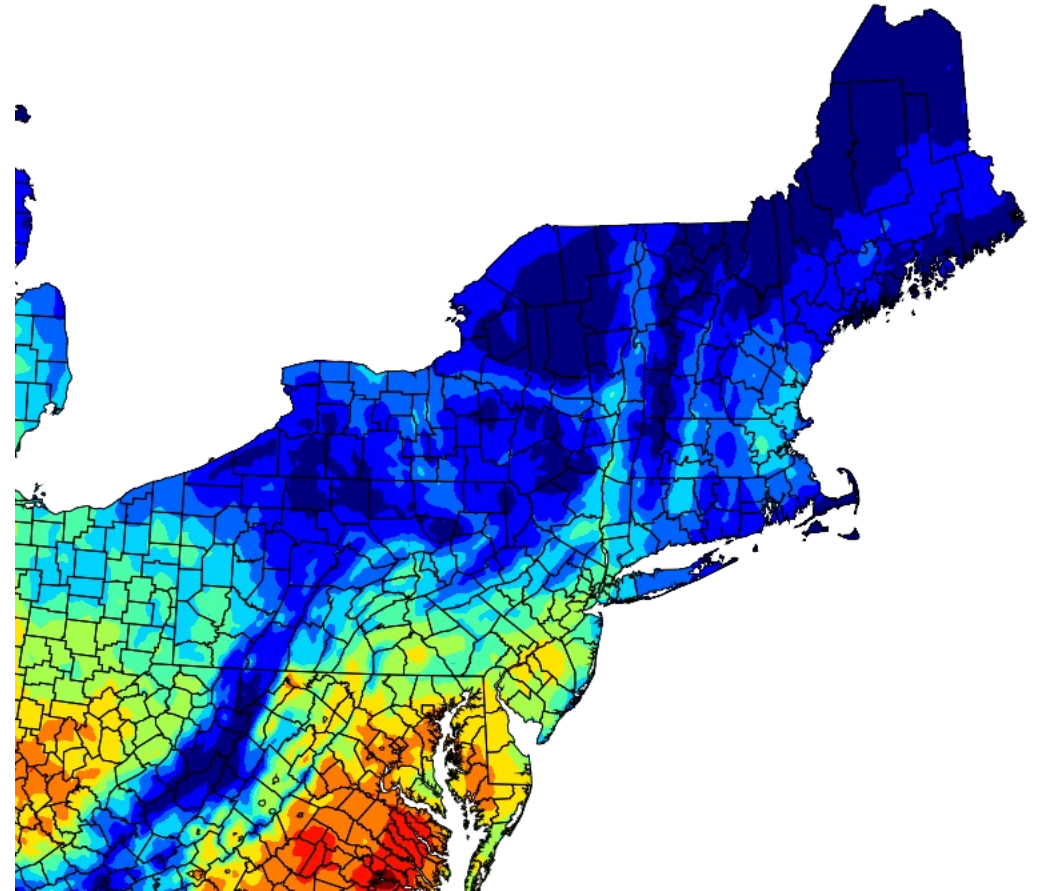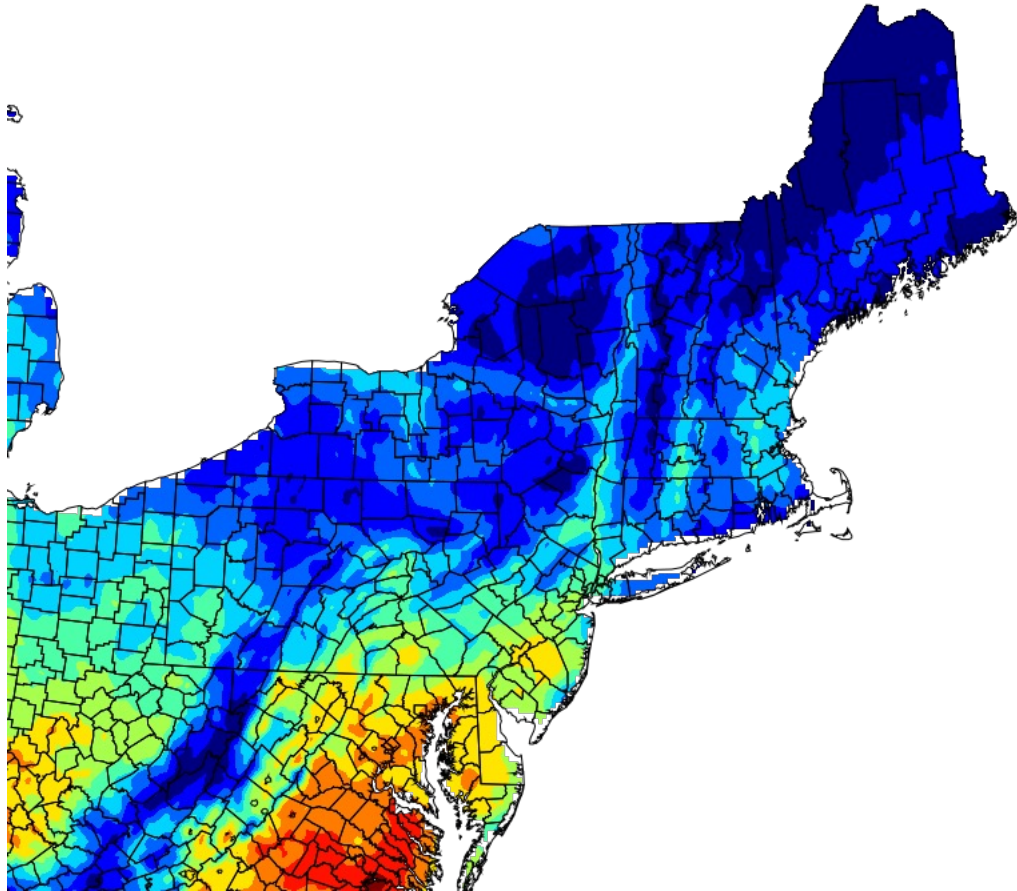
Days > 90°F
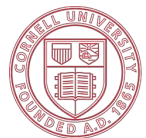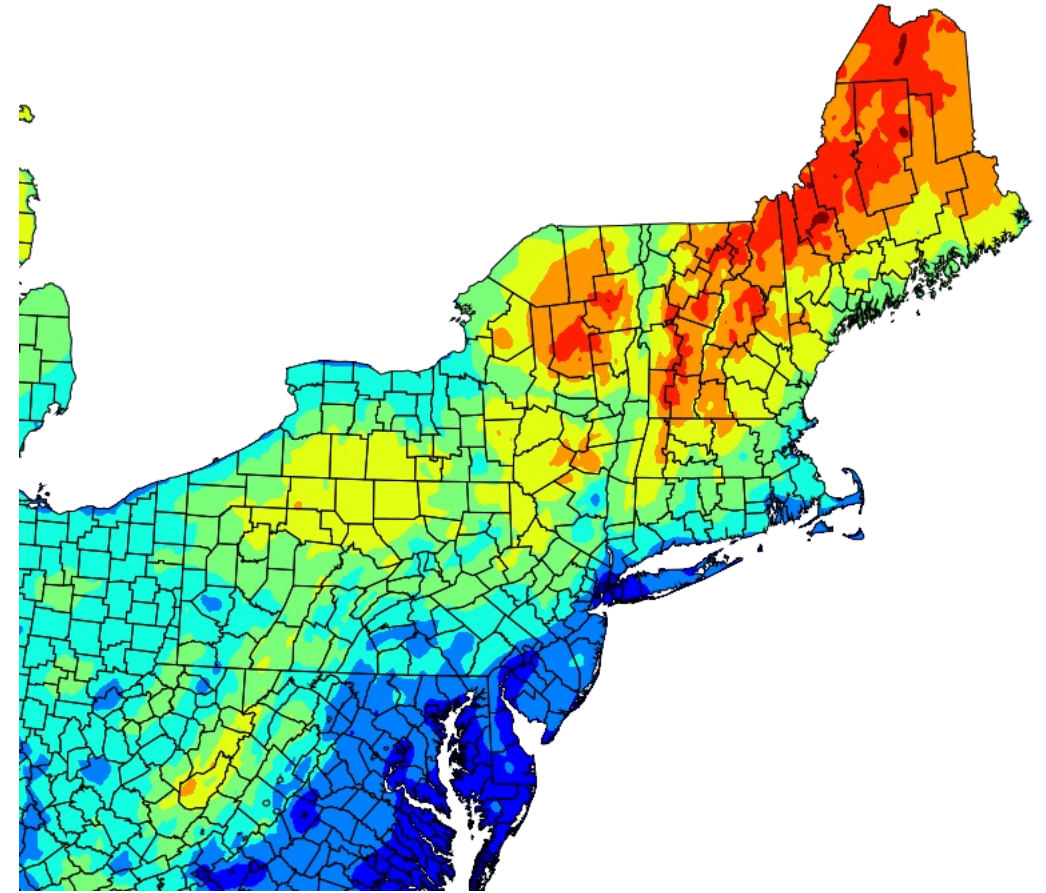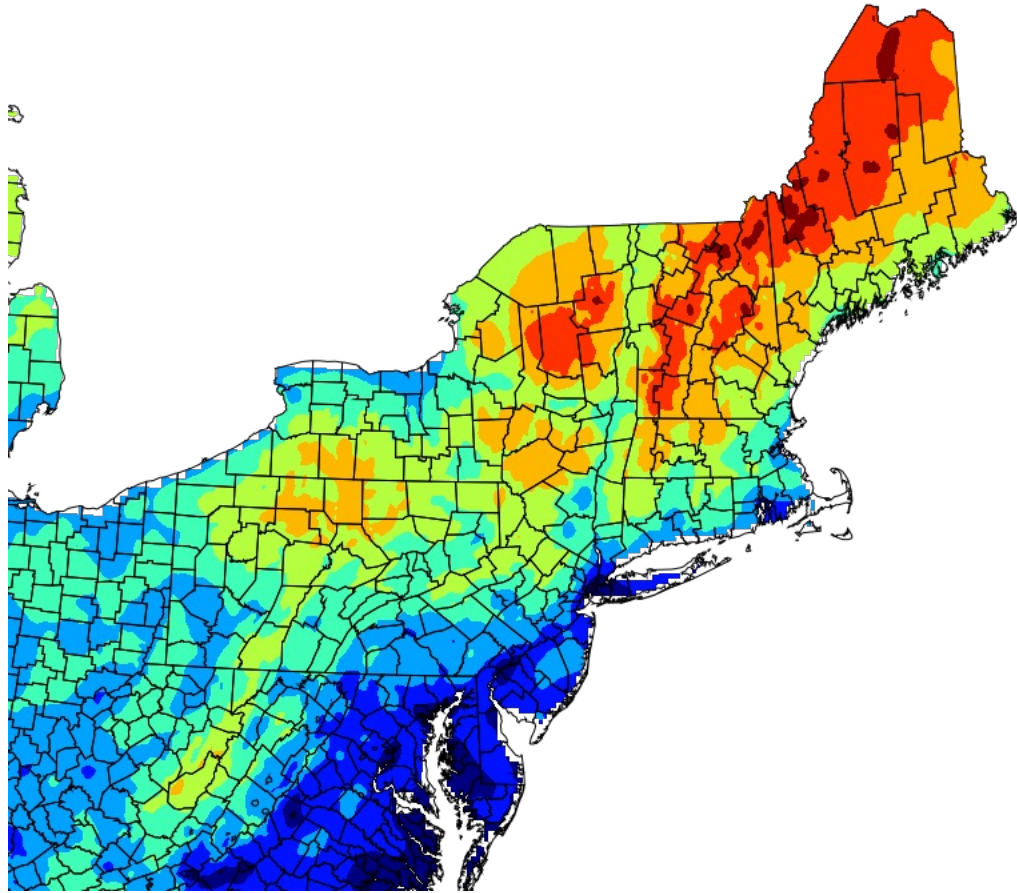
LOCA

LOCA2

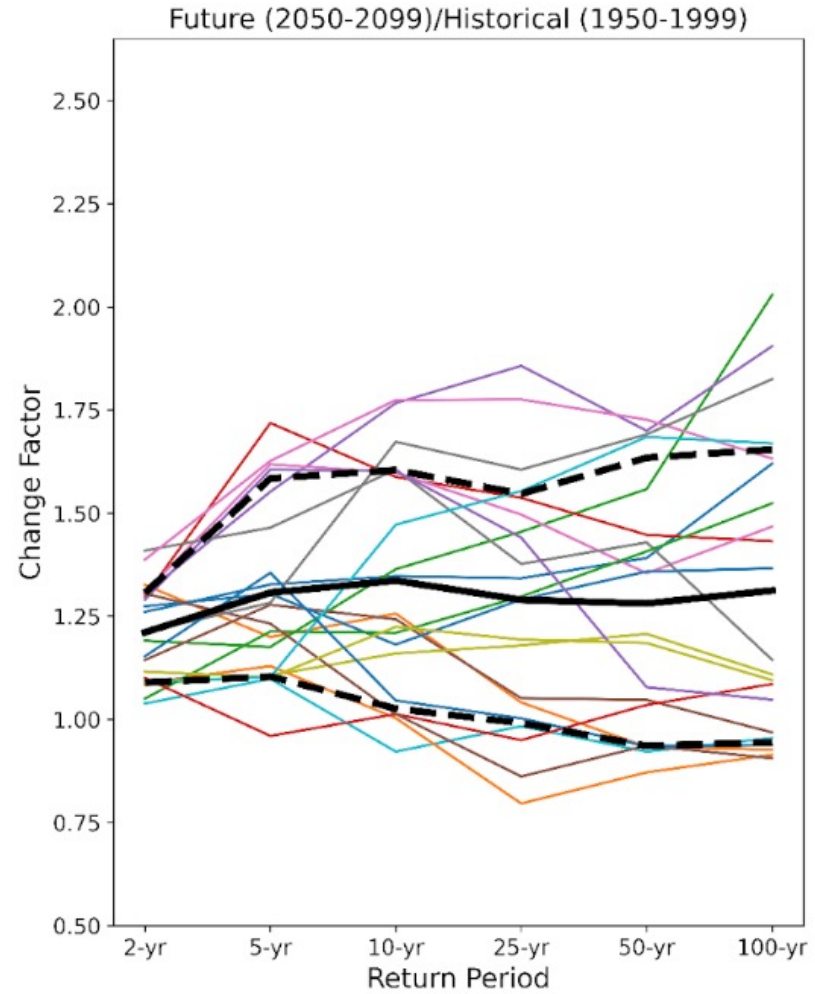Days <32°F

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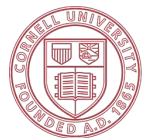
# LOCA vs LOCA2



Central Park Change Factors
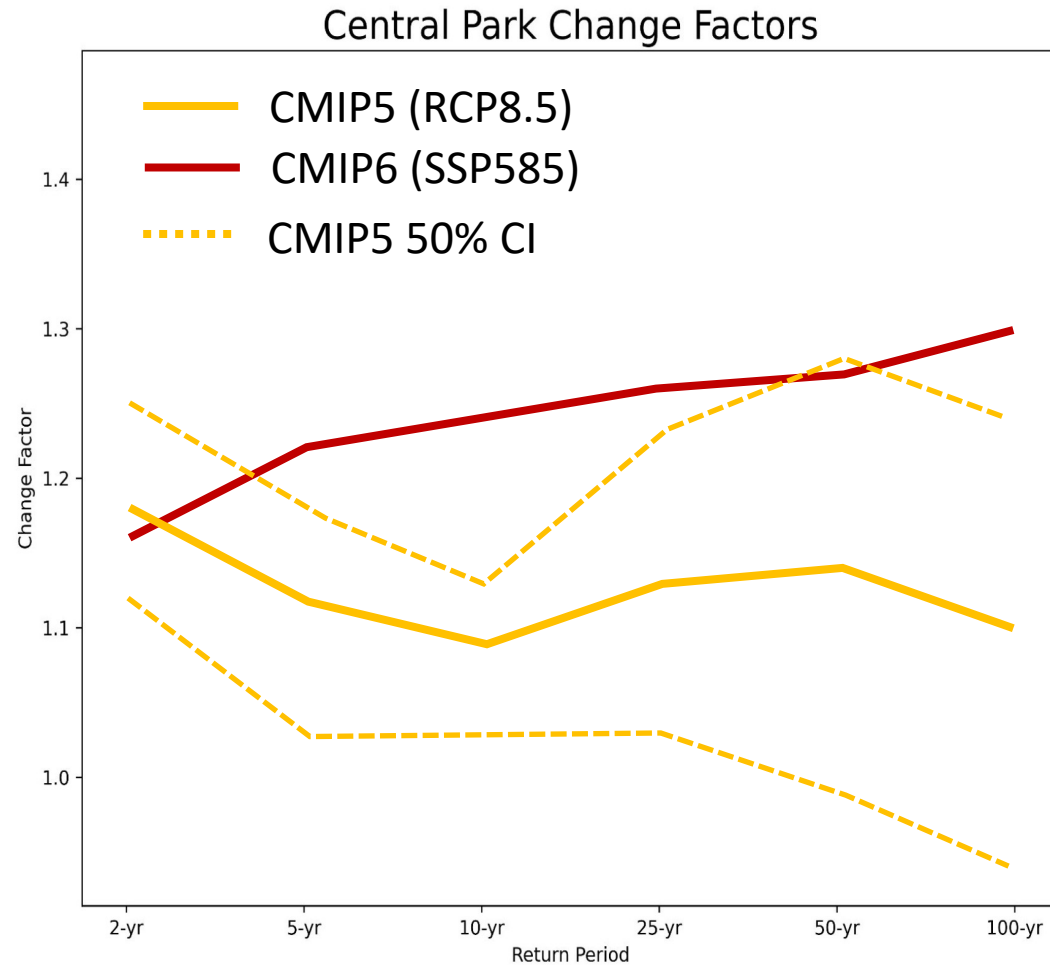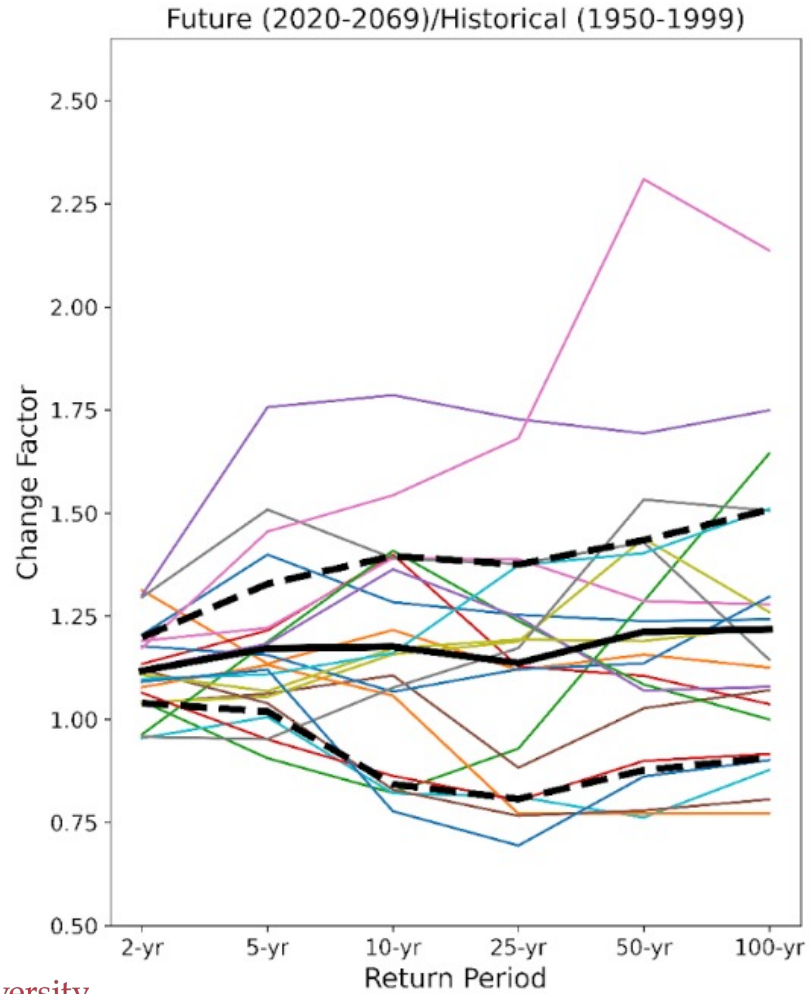
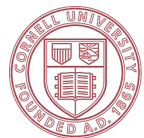**Take Home Message**: CMIP6 Extremes tend to be **LARGER** than CMIP5, especially at high return periods. Significance is Marginal
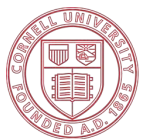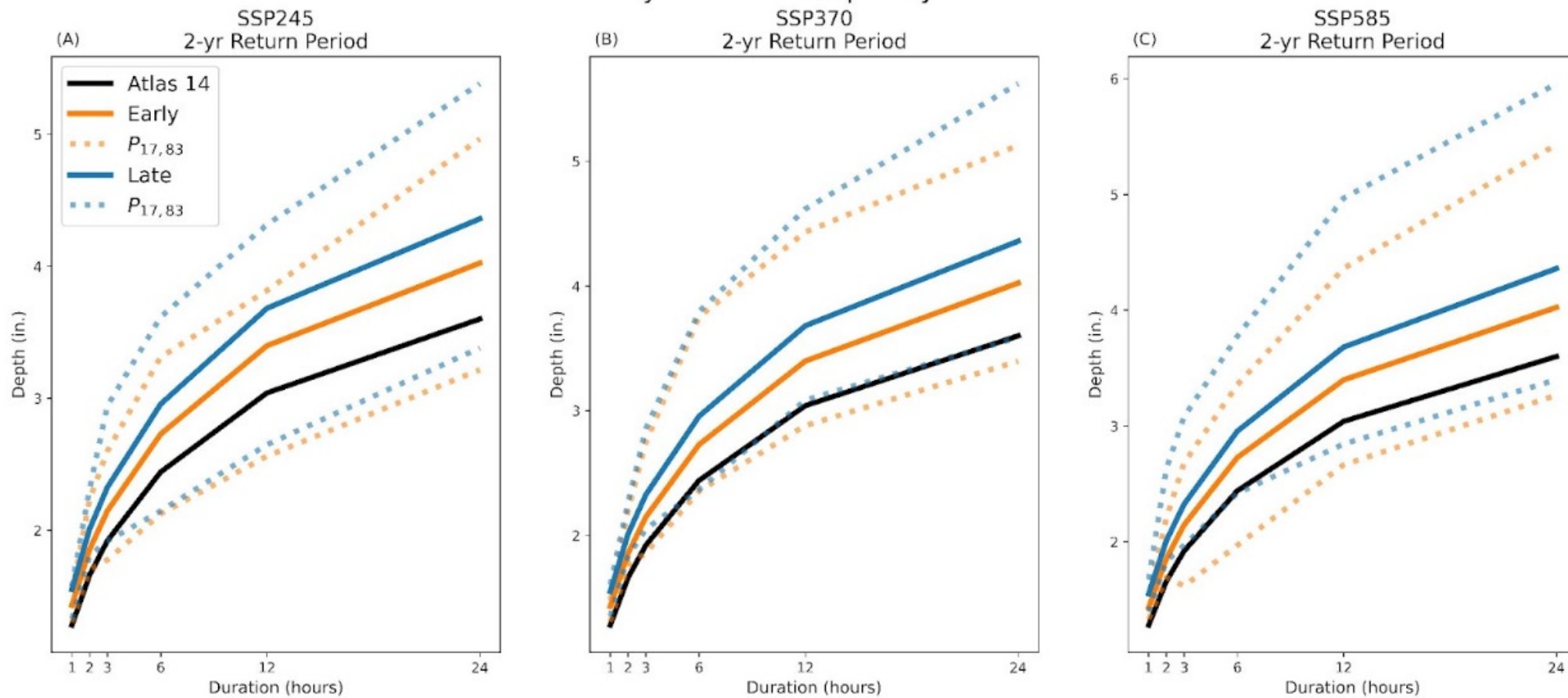
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NRCC
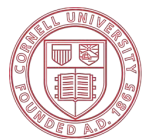
Central Park Change Factors
LOCA2 SSP585

Central Park
Intensity Duration Frequency Curves

Central Park
Intensity Duration Frequency Curves