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The Development of Climate Scenarios for the National Climate Assessment

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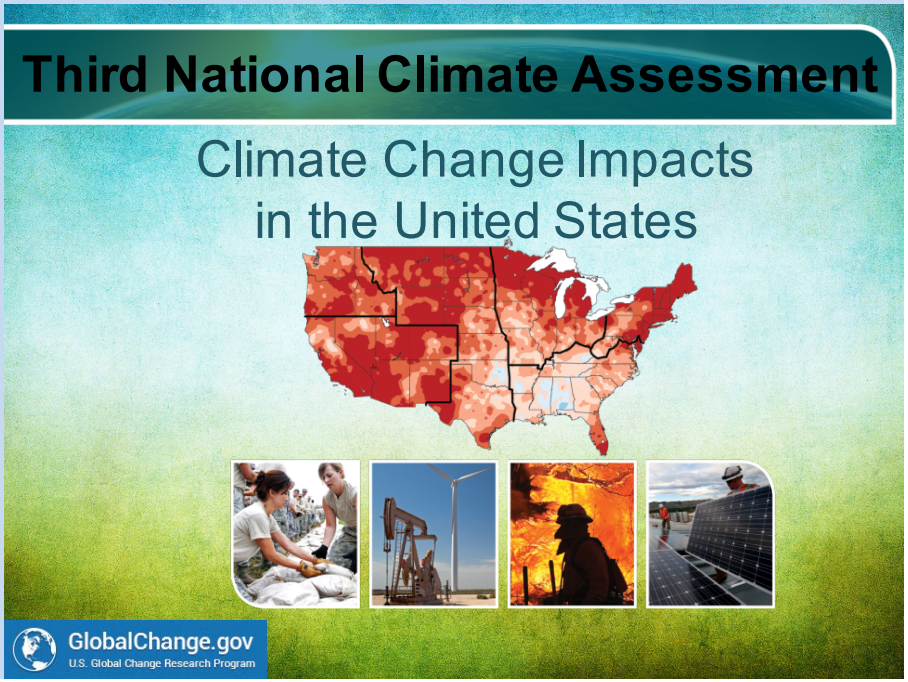
Outline

- What was done for the NCA3
  - Temperature
  - Precipitation
  - Extremes
- Path forward for NCA4 and Sustained Assessment Process
  - Downscaling
  - How we will use GCMs (CMIP5 and maybe some CMIP6).



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Goal

- Produce **actionable** regional information
- "Regional" focus of NCA imposes significant scientific challenges. Broad statements that can be made confidently on a global scale may not provide actionable information on the regional and local scale

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Temperature

- Key climate condition
- Any future large changes have profound implications for human and natural systems

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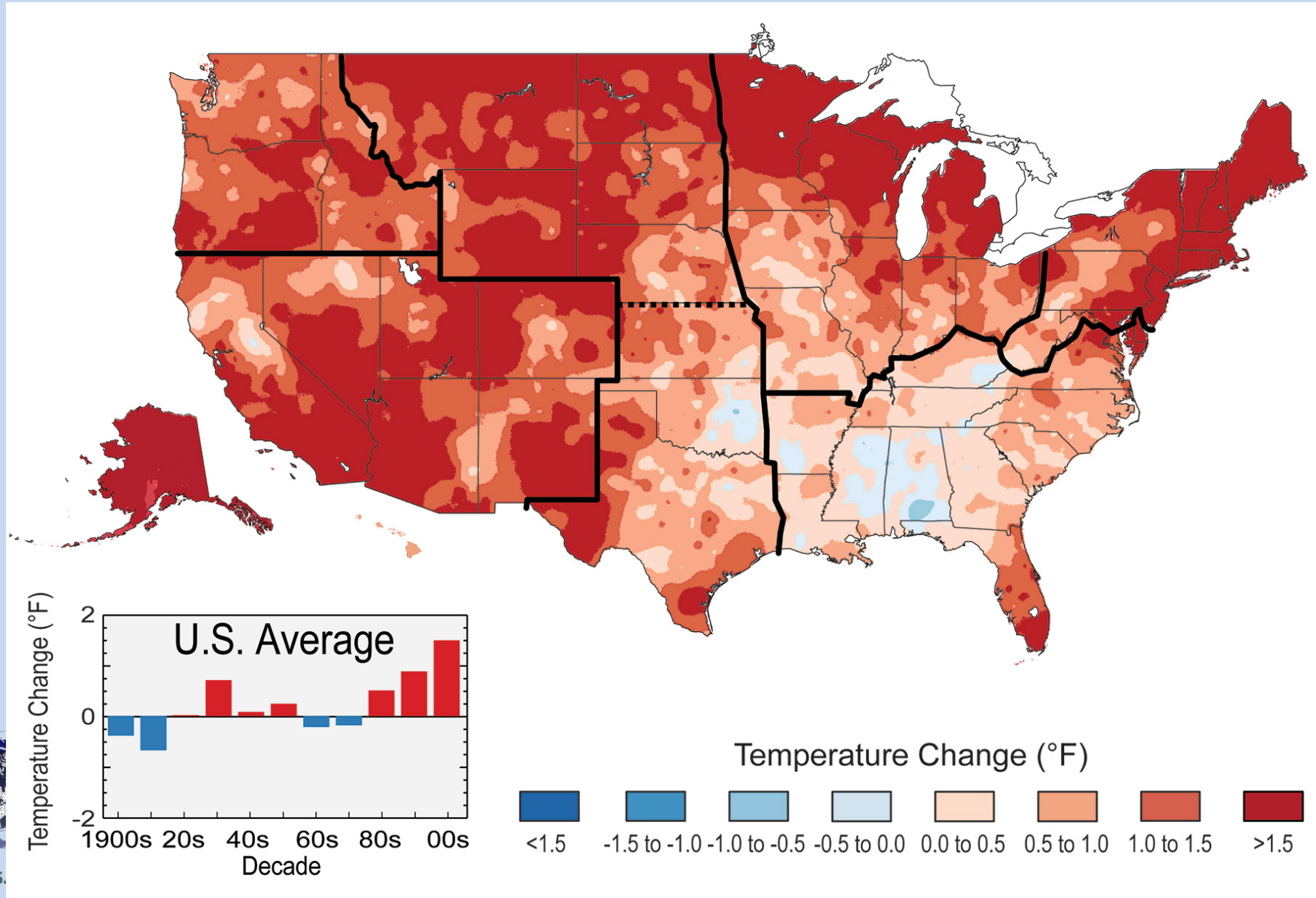
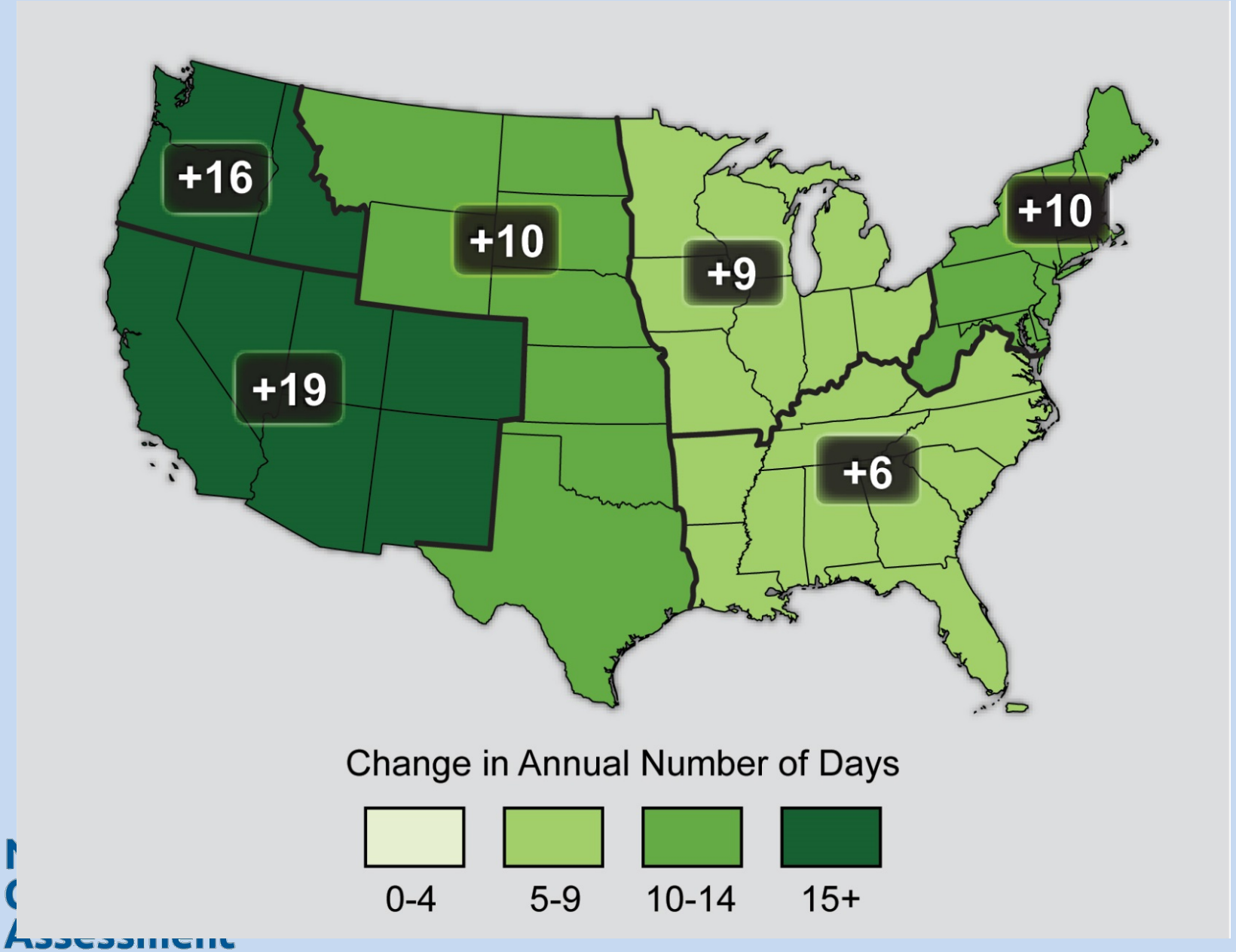
Observed Annual Temperature Change 1991-2012 compared to 1901-1960



Observed Increase in Frost-free Season



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NCA3 Projections

- Owing to uncertainty about when CMIP5 simulations would be available decision was made to use CMIP3 as primary scenarios source.
- CMIP5 simulations were used as they became available.
- NOAA produced a peer-reviewed report comparing CMIP3 results to CMIP5.

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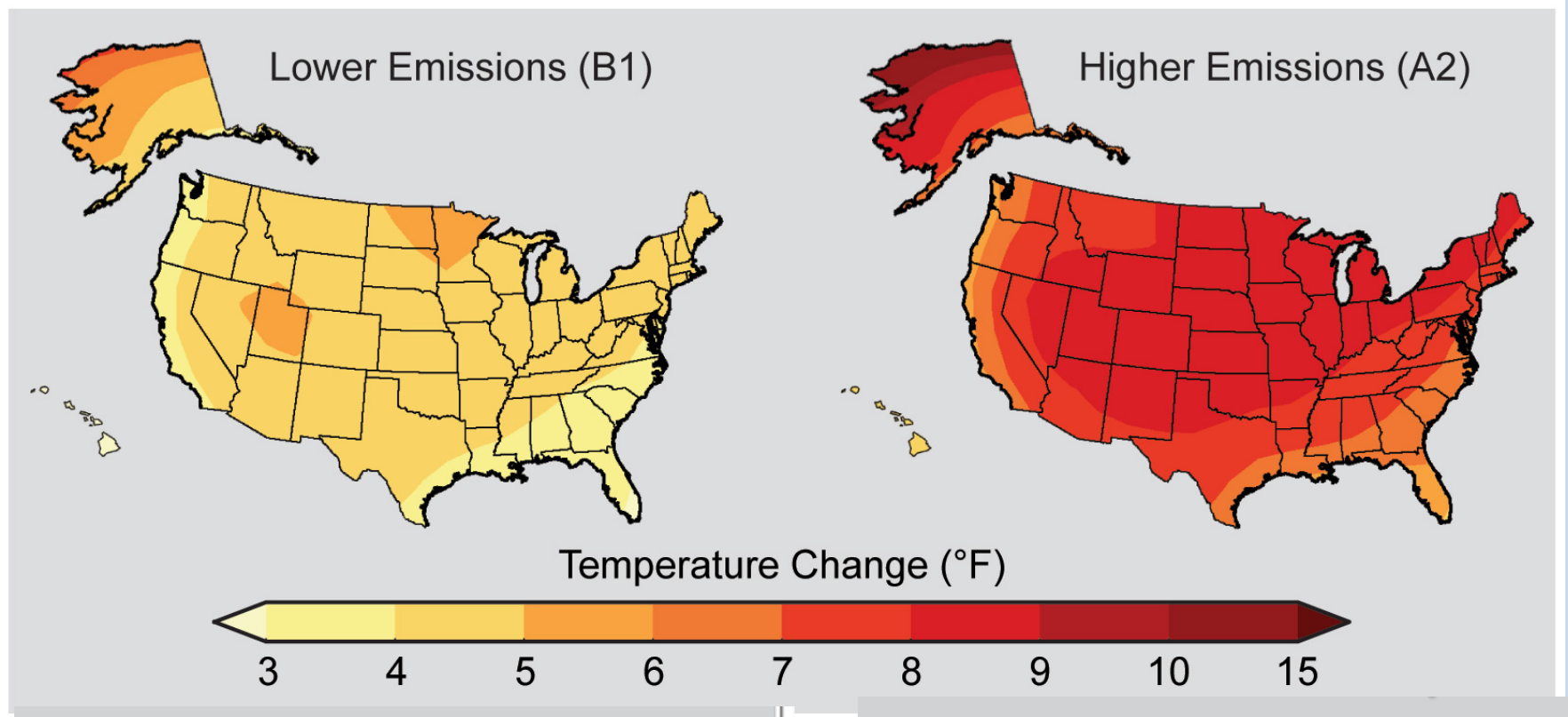
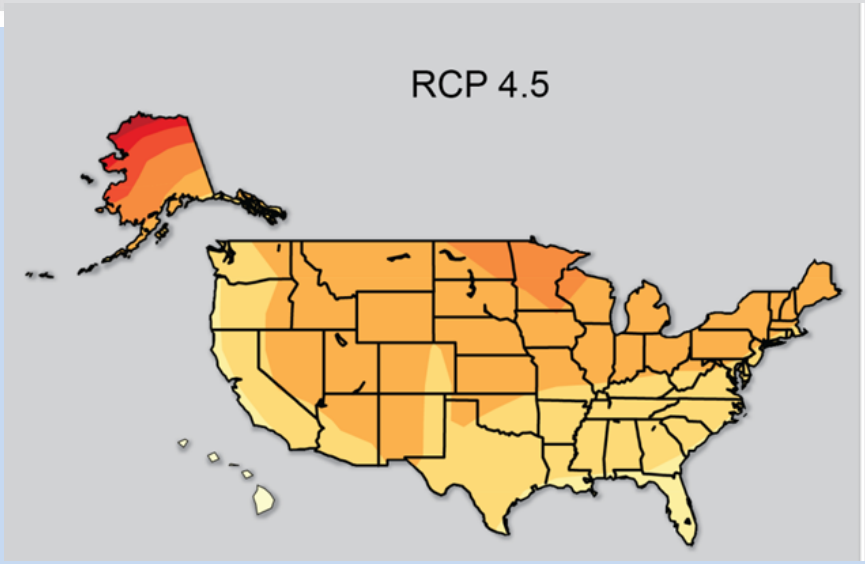
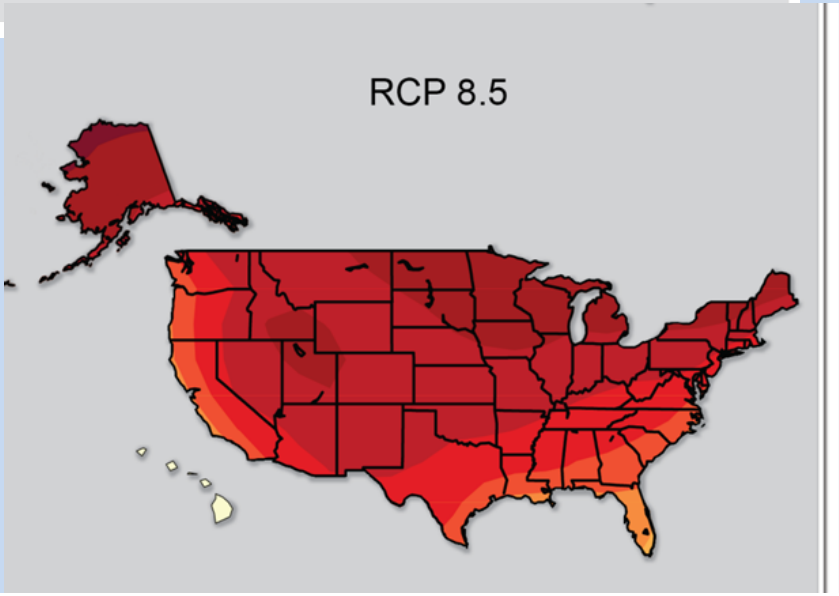
Projected Temperature Change

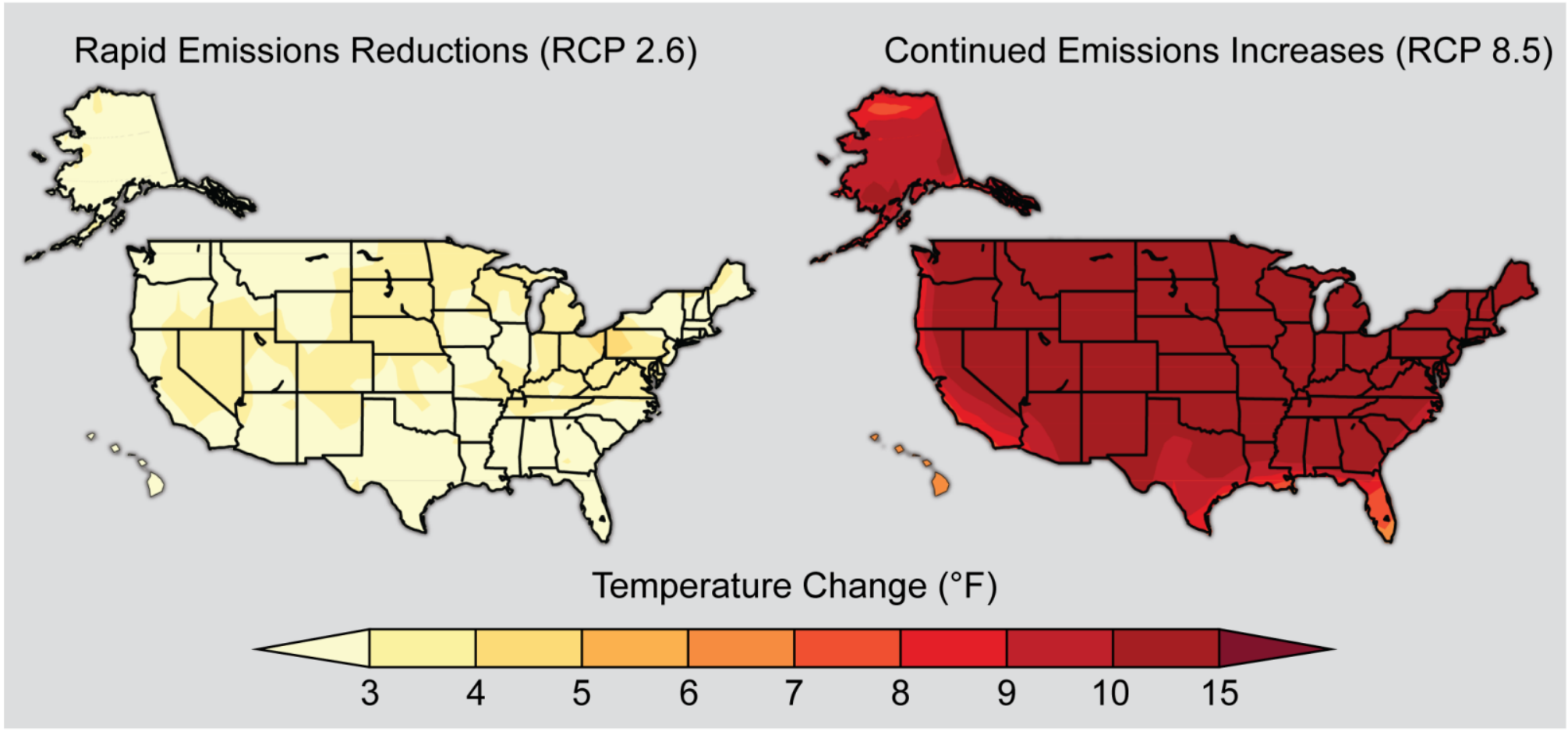






Human Health Chapter NCA3

Projected Temperature Change of Hottest Days



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Scenarios using Downscaled GCM Simulations

- Statistical: Asynchronous Regional Regressions Model data set.
- Dynamical: NARCCAP.

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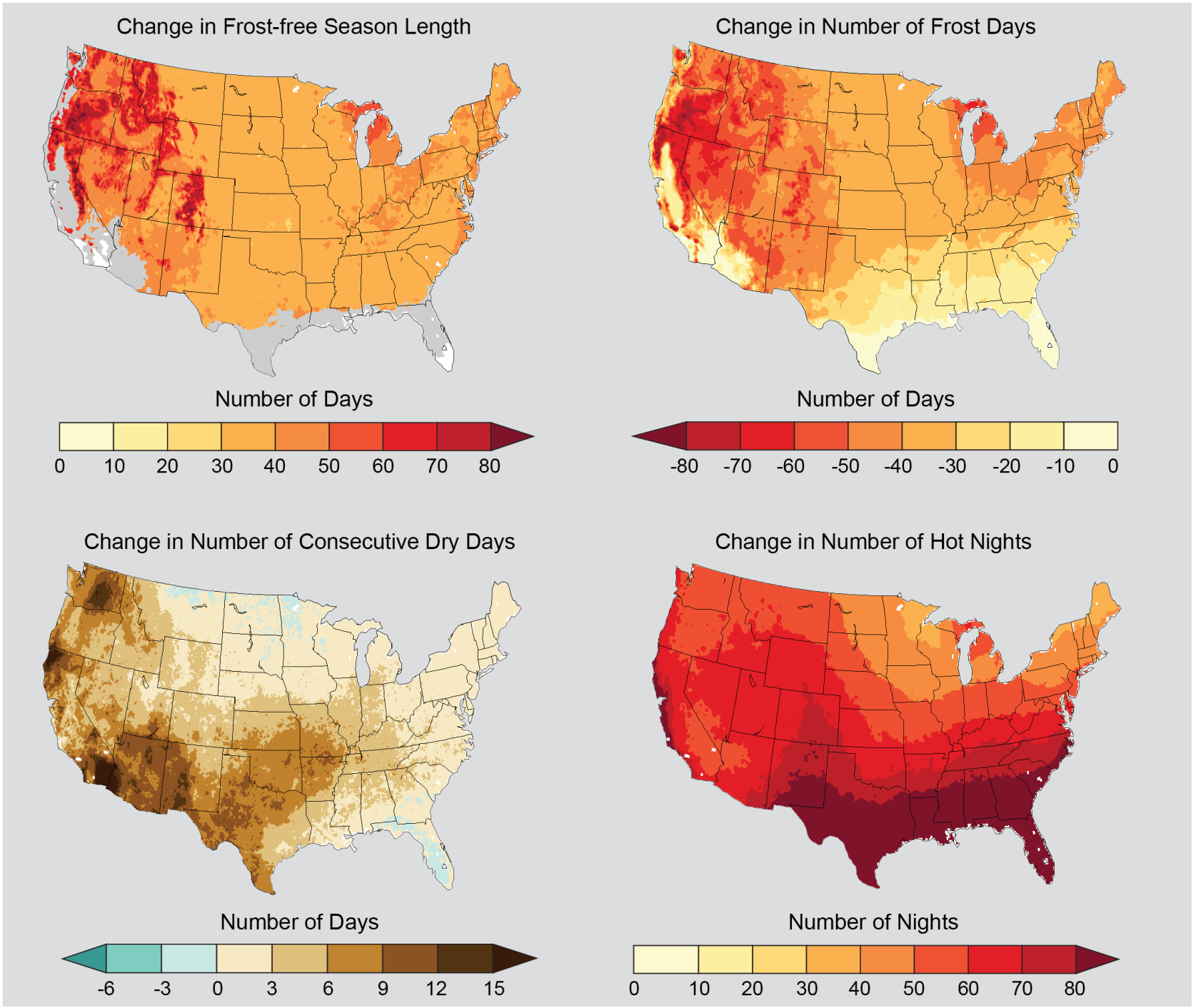
Projected Changes in Key Climate Variables Affecting Agricultural Productivity



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Precipitation

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NCA3 Findings

- More winter precipitation is projected for the northern U.S., and less for the southwest, over this century
- Increases in the frequency and intensity of extreme precipitation events are projected for all U.S. regions
- Droughts in the southwest are projected to become more intense

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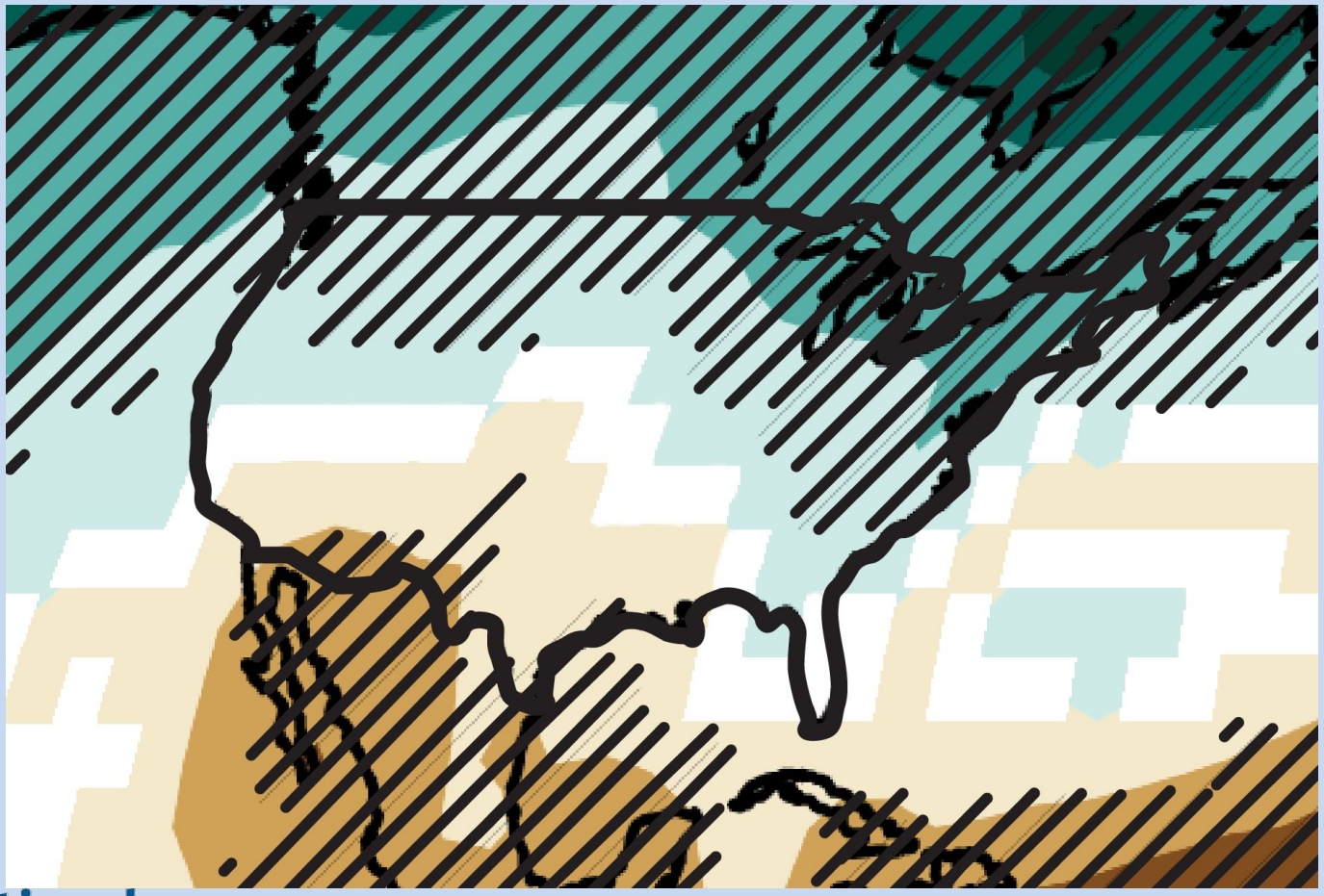
Projected Change in Average Annual Precipitation

Continued Emissions Increases (RCP 8.5)



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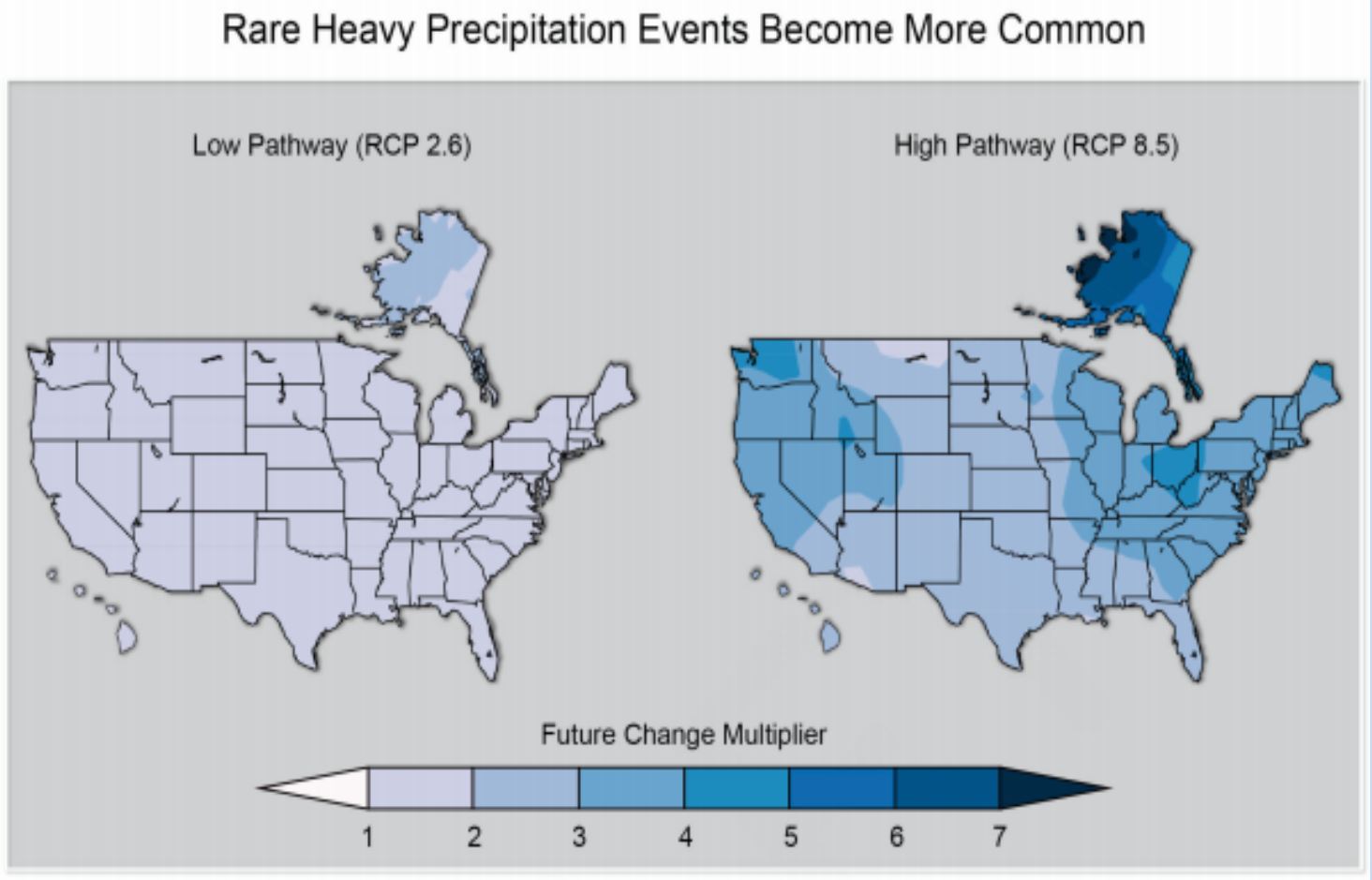
Rare Heavy Precipitation Events Become More Common

- Once-in-20-year events
- Low emissions scenario (left)
  - Up to about twice as often
- High emissions scenario (right)
  - Up to five times as often



Melillo et al. 2013 National Climate Assessment

Precipitation – What do we know

- In one sense, a great deal
  - Very consistent global patterns (wetter high latitudes and tropics, drier subtropics
  - Physical understanding of the model outcomes
    - Hadley cell strengthening
    - Water vapor increases: potential for heavier rainfall

- At the typical decision-maker scale, not as much as desired
  - Considerable range of outcomes and uncertainties

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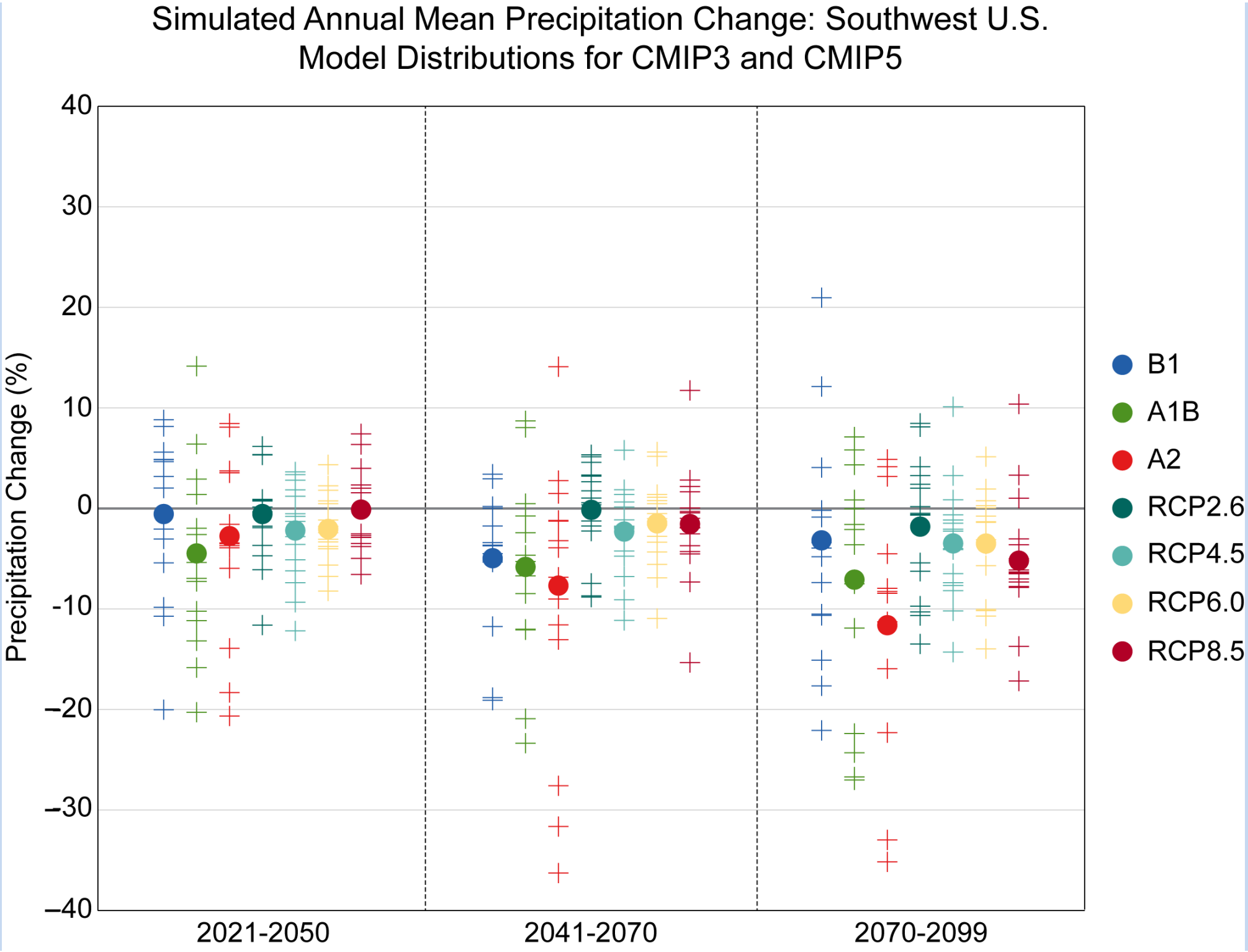
Simulated Annual Mean Precipitation Change: Southwest U.S.
Model Distributions for CMIP3 and CMIP5
Precipitation Change (%)
40
30
20
10
0
-10
-20
-30
-40
2021-2050
2041-2070
2070-2099
B1
A1B
A2
RCP2.6
RCP4.5
RCP6.0
RCP8.5

Scientific Paths Forward?

- Better models are always desired
  - Convective precipitation is a central issue
  - Higher resolution: in order to achieve more than incremental improvements, is it necessary to go to cloud resolving resolution?
  - Better representation of physical processes-clouds, radiation, convection
- Limited by cost and physical understanding
- Different approaches to CMIP?
  - Targeted foci on processes, e.g. monsoons, summer systems

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Paths Forward?

- Climate Scenarios Task Force
  - Charged with developing recommendations for climate scenarios approaches for NCA4 and Sustained Assessment Process.

  - Chris Weaver, Chair, EPA and USGCRP
  - David Easterling, Co-Chair, NOAA
  - Ben DeAngelo, EPA and USGCRP
  - Jeremy Littell, USGS
  - Weile Wang, NASA, Cal State U, Monterrey
  - Subrendu Gangopadhyay, BoReclamation
  - Radley Horton, Columbia University
  - Ken Kunkel, NC State and NOAA
  - Robin Webb, NOAA
  - Michael Wehner, Lawrence Berkeley NL
  - Jeff Arnold, US Army CoE
  - Glynis Lough, USGCRP
  - Fred Lipschulz, NASA/ USGCRP
  - Don Wuebbles, U of Illinois and OSTP

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Questions Being Considered

- GCMs: CMIP5, RCP4.5 and RCP8.5 as focus, what about RCP2.5 and RCP6.0?

- GCMs: Is model democracy dead?
  - Should all GCMs in CMIP5 be included in ensemble averages with the same weight?
  - Sanderson et al. (2015) developed a set of weights based on ability of GCM to simulate observations and model independence. This approach or similar could be used.

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Questions Being Considered

- Downscaling (Statistical)
  - Need daily and monthly.
  - Multiple methods using CMIP5 (e.g. LOCA, BCSD, others?)

- What do we produce?
  - Ensemble averages
  - Indices (e.g. CLIMDEX, others)

- Extremes?
  - Are there other approaches to producing information products for future climate?

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Questions?