CMIP5 vs. CMIP5 Climate Projections

With relevance to UCRB

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Outline

- CMIP5
  - GCMs
  - What's new?
- CMIP5 vs. CMIP3 projections
  - Large Scale Comparison
  - Upper Colorado River Basin
- Major uncertainties in climate models for the western US

Global Climate Models (a.k.a. GCMs)

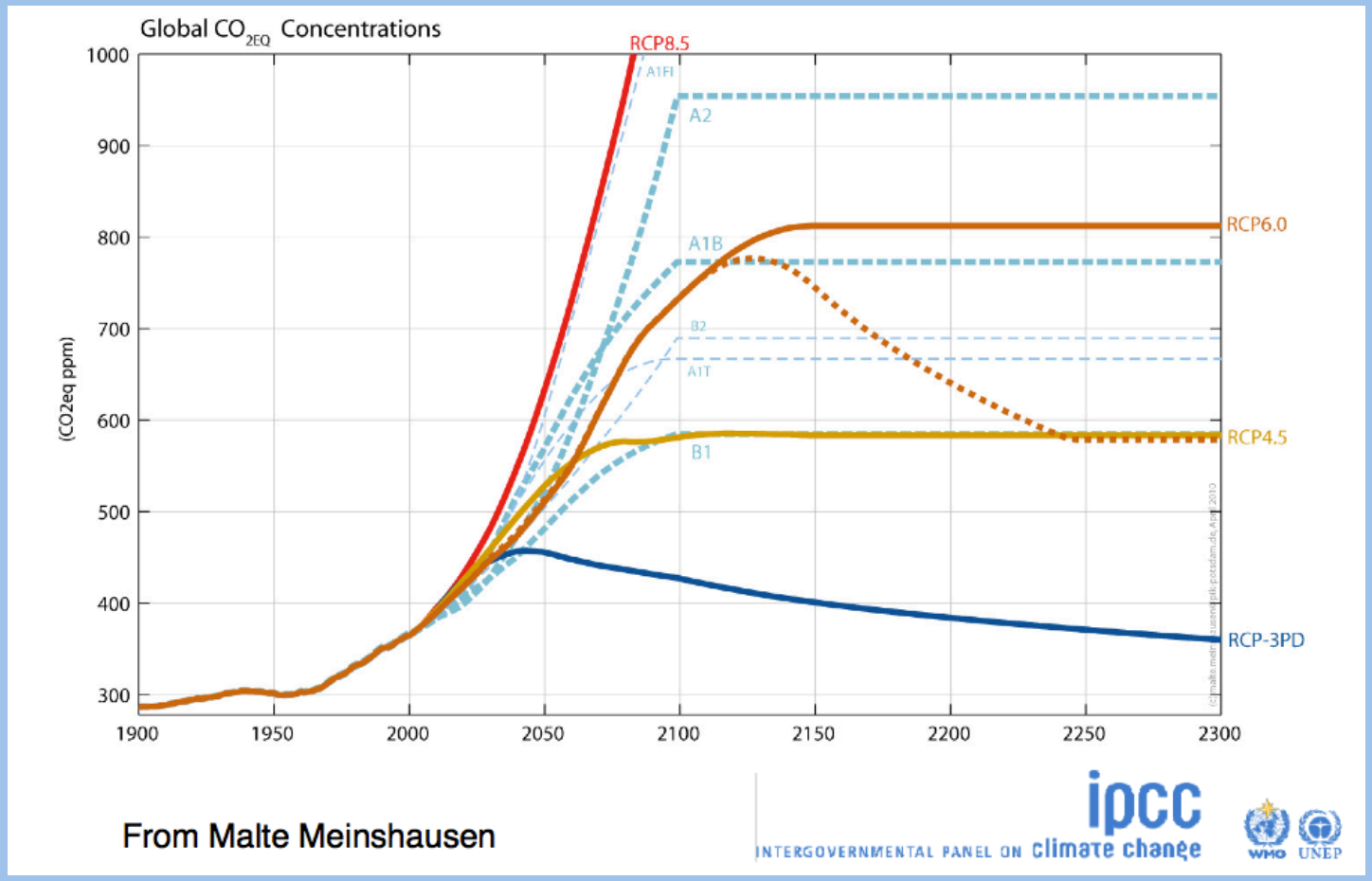
- Primarily to simulate climate processes at large scales (1000 km)

- Greater confidence in projections at those scales; uncertainties increase at regional and sub-regional scales

CMIP5: What's new?

- New emission scenarios
- Many more model simulations
- Many more climate variables archived
- Output also available at daily timestep – suitable for analysis of climate extremes
- Inclusion of Earth System Models in the mix
- Improvements in representing certain physical processes, e.g. Ocean Circulation
- Higher spatial resolution

RCPs: The New Emission Scenarios



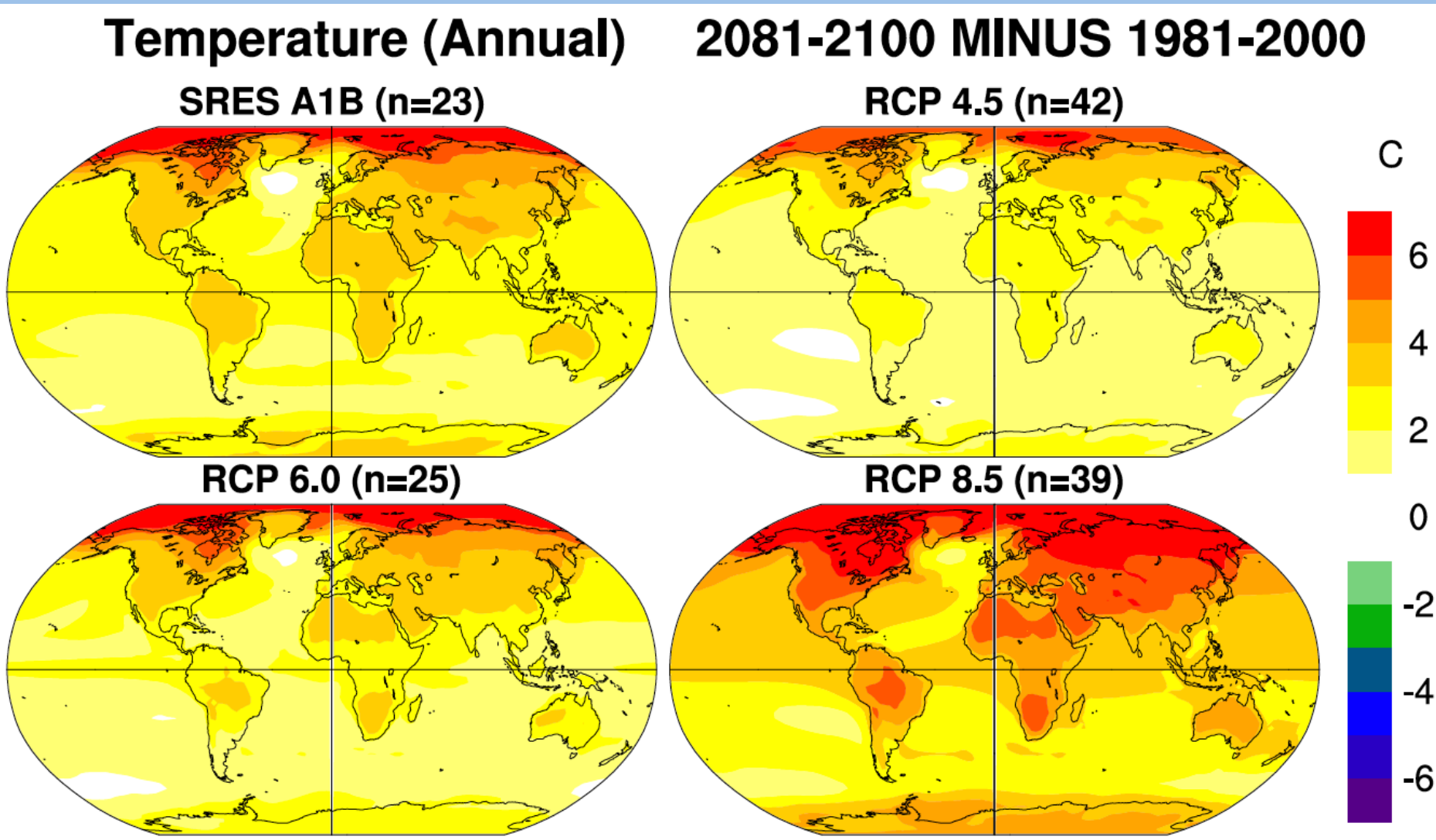
- RCPs: 2.6 (3PD), 4.5, 6.0, 8.5
- RCPs 4.5 & 8.5: Core Scenarios for CMIP5 simulations
- RCP 4.5 ≈ SRES B1; RCP 6.0 ≈ SRES A1B; RCP 8.5 ≈ SRES A1F1
- Mid-21st century: RCP 4.5, 6.0 and SRES A1B, A2 have similar greenhouse forcings

CMIP5 vs. CMIP3

Some Comparisons

Ensemble Mean

Globally, spatial pattern of change very similar between CMIP3 and CMIP5

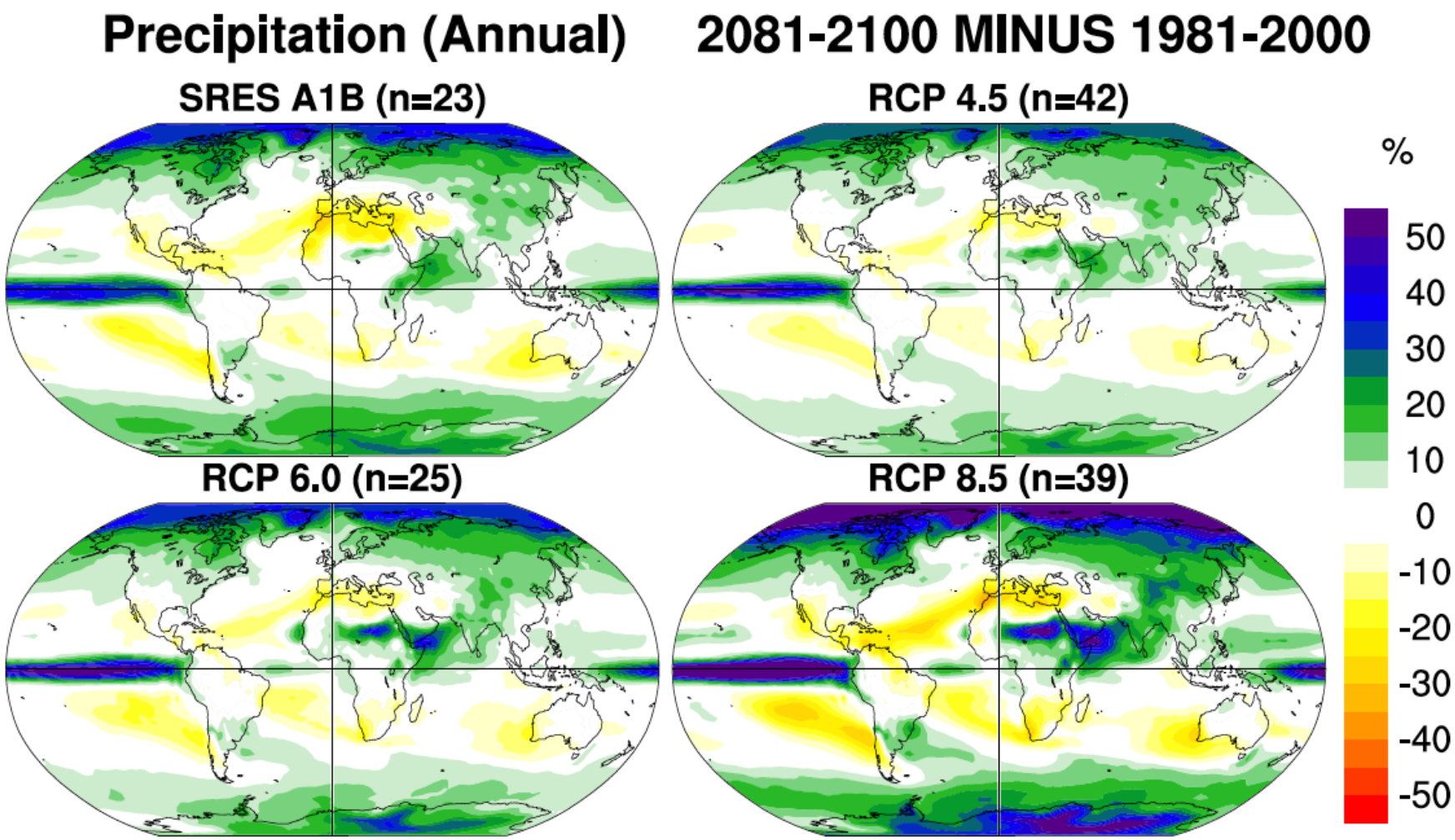


n = # of individual model ensembles (many more individual models in there)

- These similarities consistent at seasonal scales
- Magnitude of change is generally a function of the emission scenario

Ensemble Mean

Globally, spatial pattern of change very similar between CMIP3 and CMIP5



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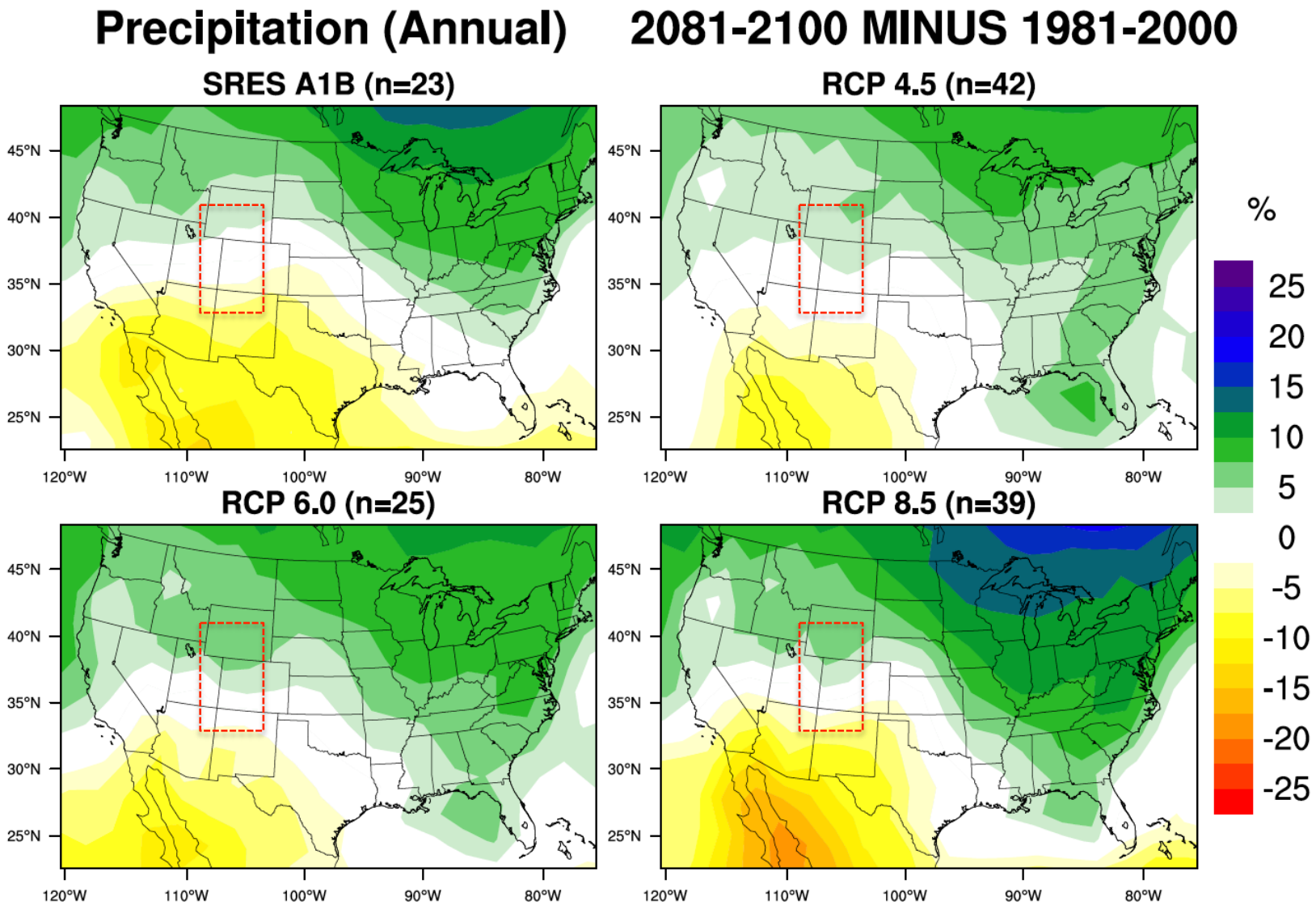
Ensemble Mean

Zooming in….



- Broader scale patterns remain the same between CMIP3 and CMIP5 but some regional scale differences noticable. Are they significant for the Upper CO Basin?

Upper Colorado River Basin

GCM with "1° resolution ≈ 100km" has 49 grids

GCM with "2° resolution ≈ 200km" has 16 grids

Analytical Approach

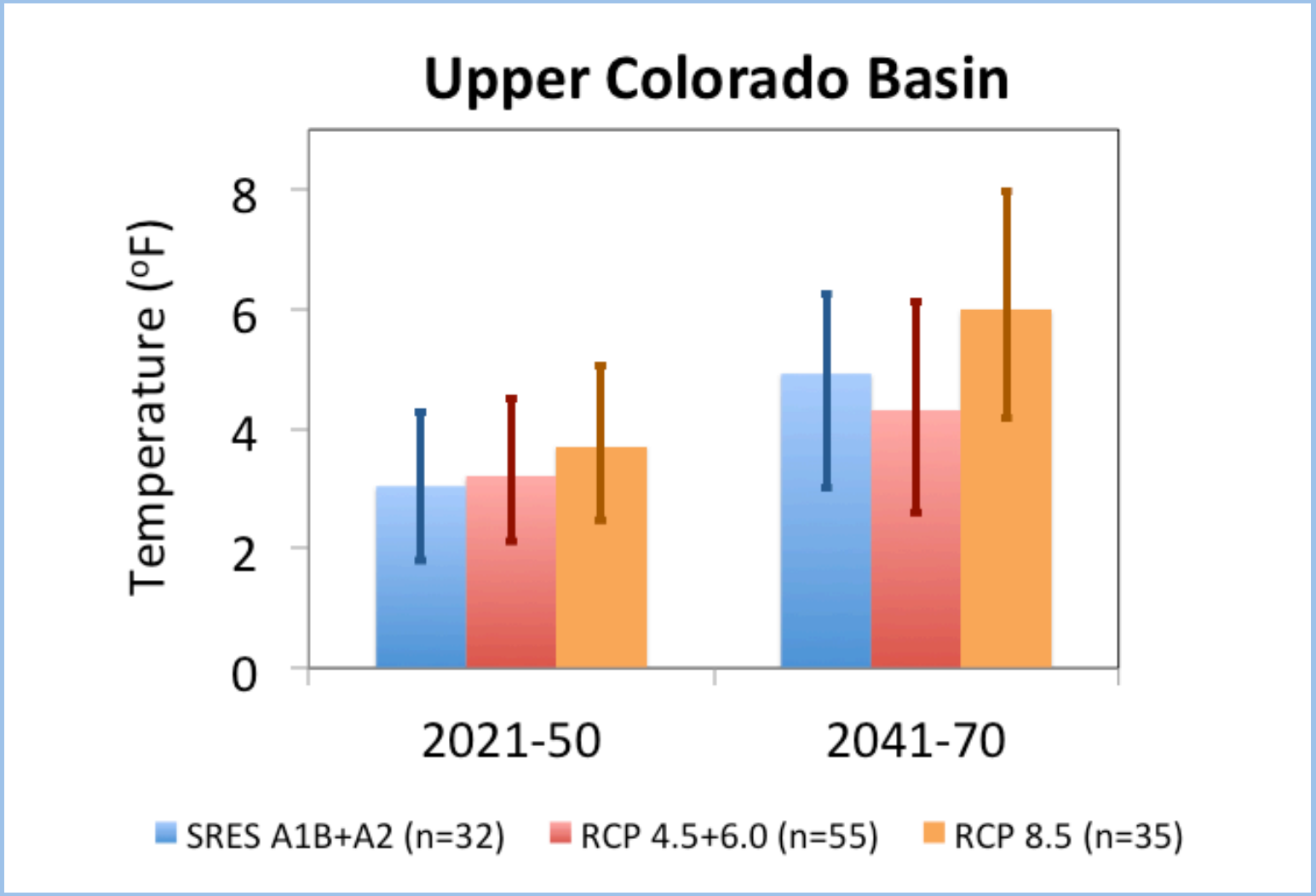
- Equal weighting for each GCM
- Mid-century: 2041-2070

CMIP3 → SRES A1B + A2
CMIP5 → RCP 4.5 + 6.0

} Similar Greenhouse Forcings

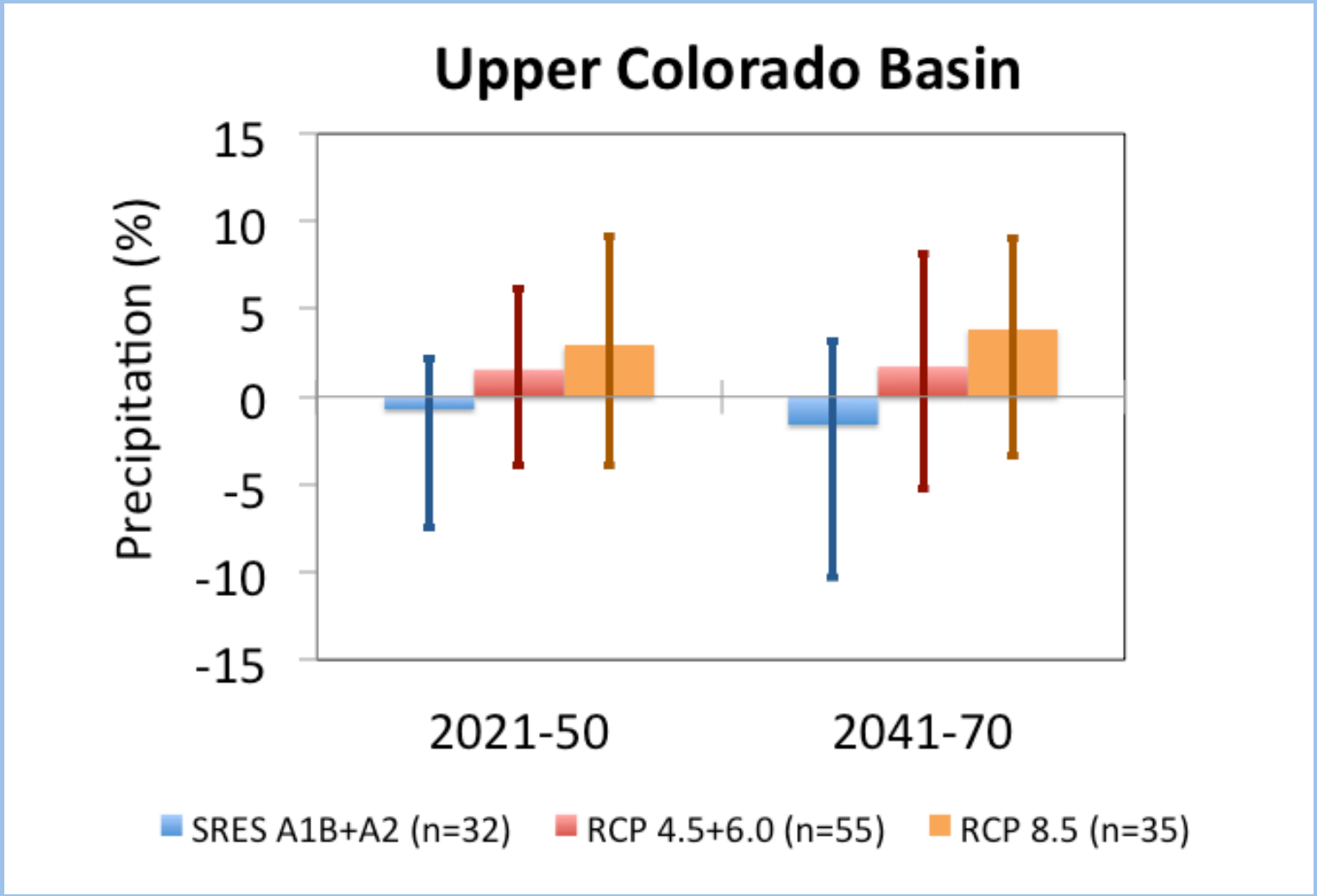
CMIP5 → RCP 8.5 (shown separately)

CMIP3 vs. CMIP5: Early and Mid Century Changes



Bar plot shows median changes relative to 1971-2000; error bars are 10th and 90th percentiles

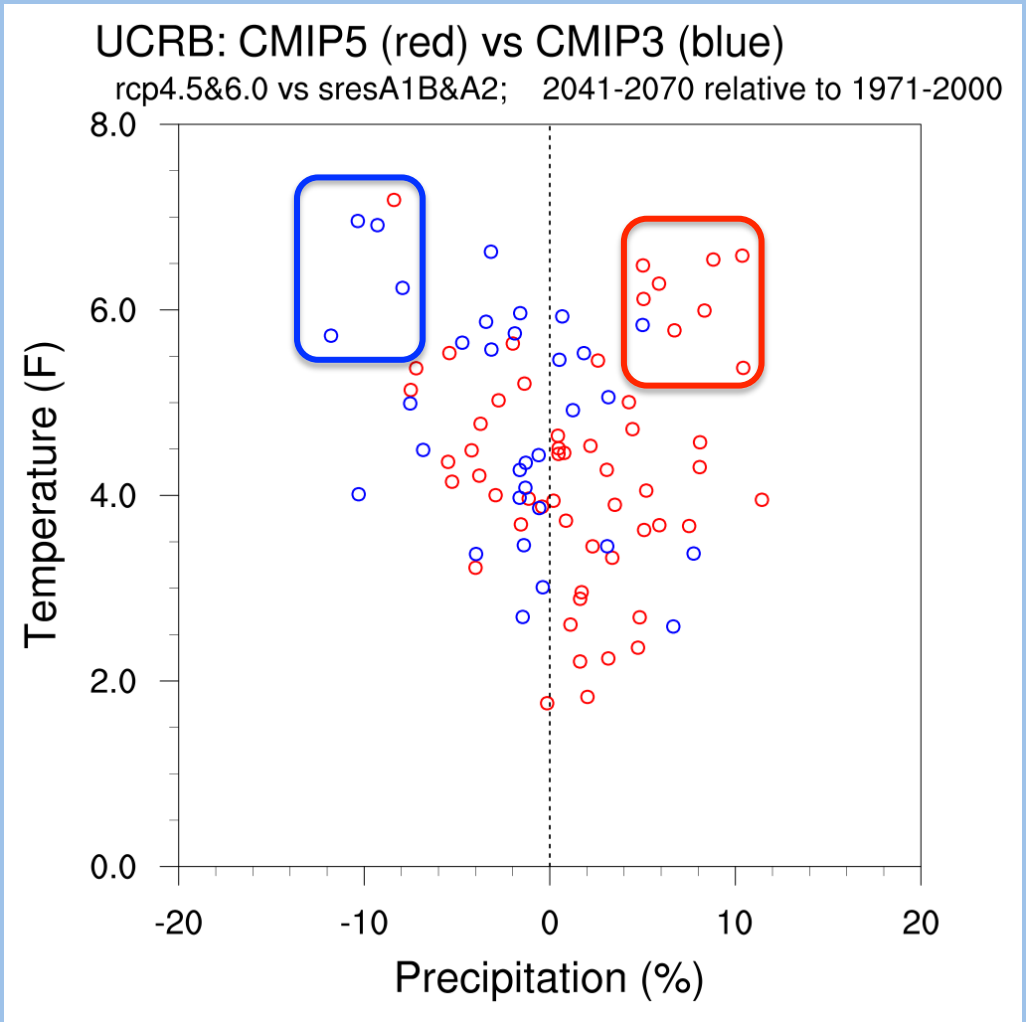
CMIP3 vs. CMIP5: Early and Mid Century Changes



- ✧ Median change in slight positive in CMIP5; slight negative in CMIP3
- ✧ Uncertainty related to the sign of precipitation change and the spread across models are still quite large

Upper CO Basin

CMIP3 vs. CMIP5: Mid Century Changes



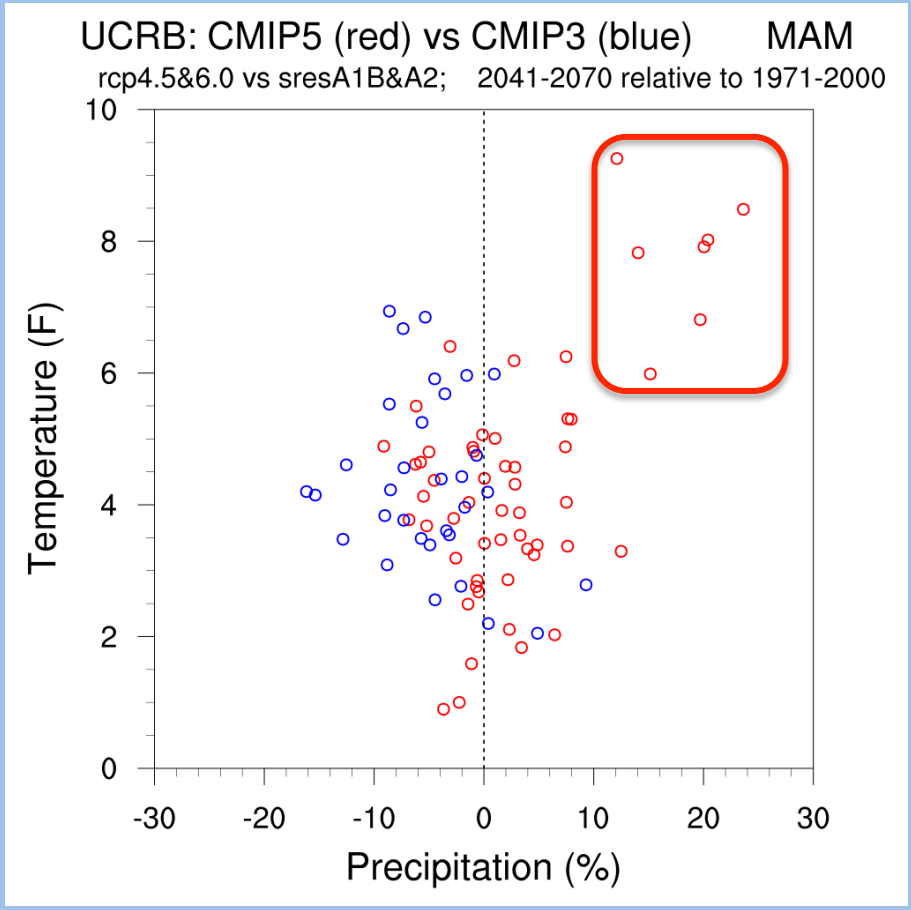
- Central tendency slightly wetter (<5%) in CMIP5 than CMIP3
- Differences in the tails:

  A few cases of hot(6F)/dry(-10%) in CMIP3 vs. hot(6F)/wet(+10%) in CMIP5

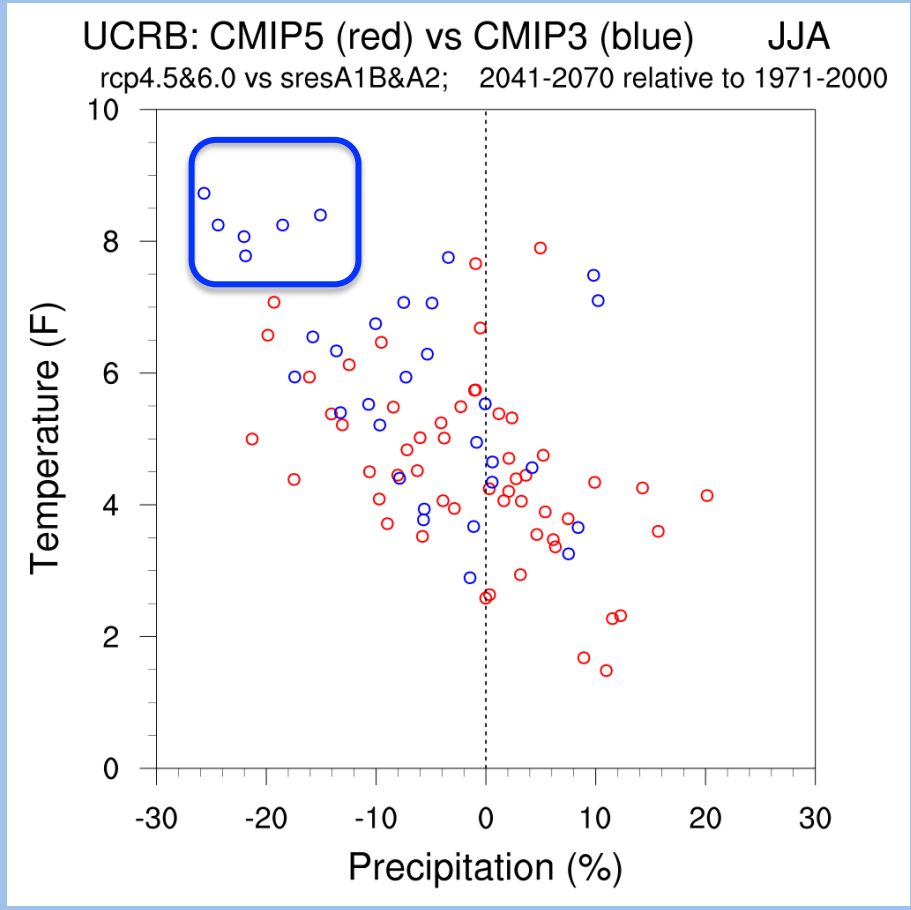
Upper CO Basin

CMIP3 vs. CMIP5: Spring & Summer

Spring



Summer



Differences found for:

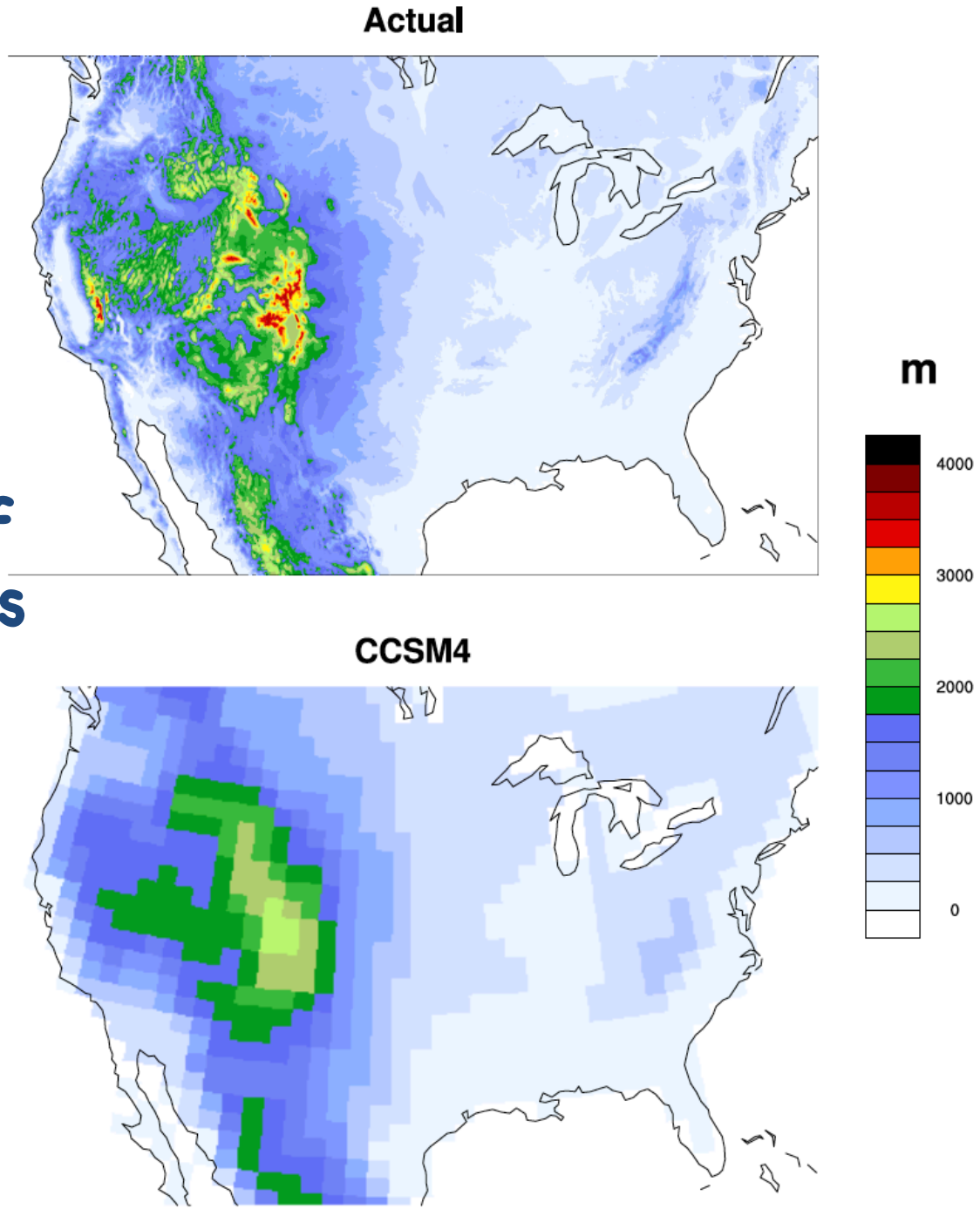
Spring: Unlike CMIP3, more than half of the models show increases in precip; a few show large hot/wet trends

Summer: CMIP5 has more cases of relatively wetter and cooler summers than CMIP3

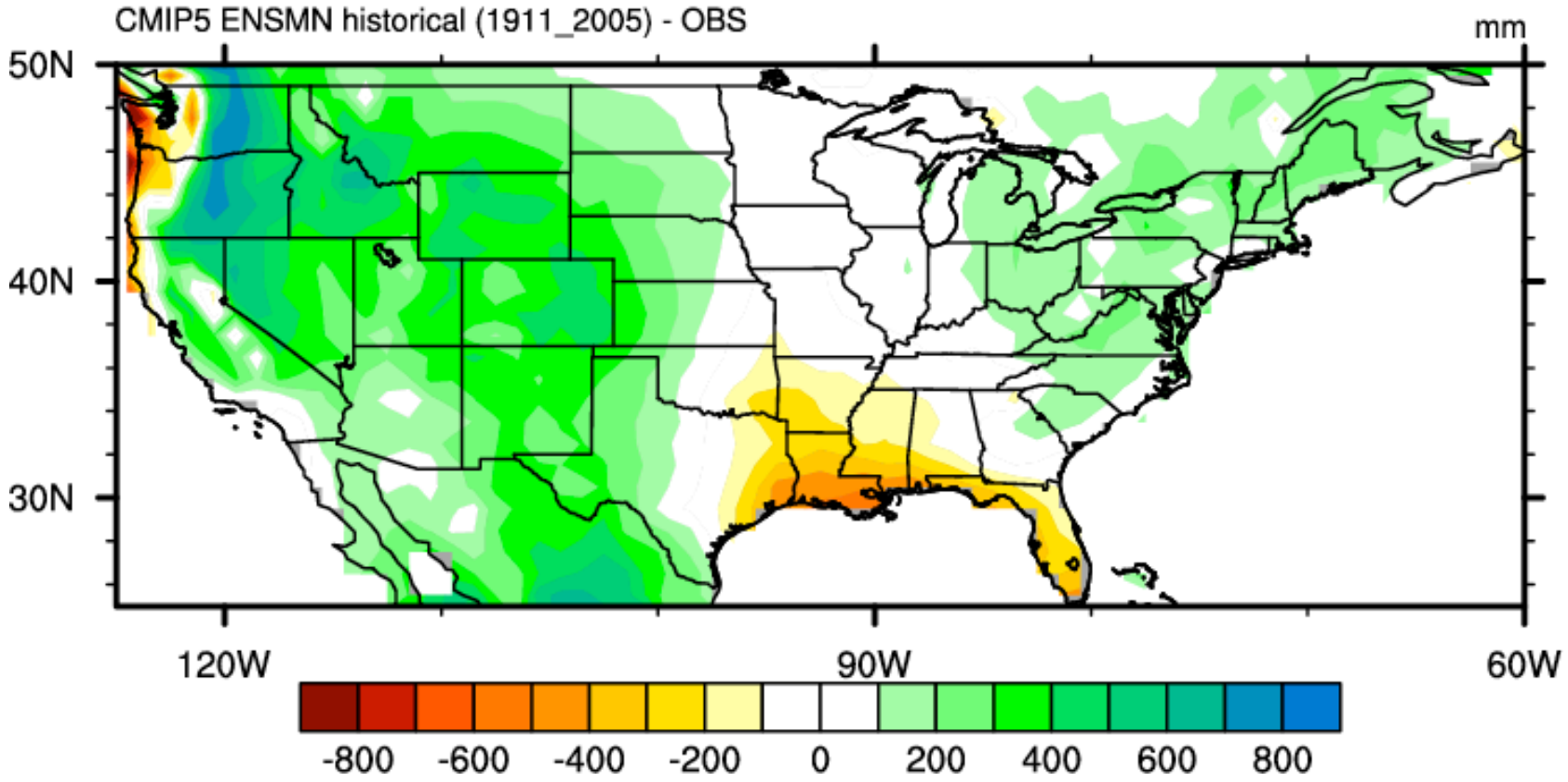
Some major uncertainties in climate models for the western US

That are still present in CMIP5

Inadequate representations of mountains in GCMs



Large positive precipitation bias for Western US remains in CMIP5 models



NOAA ESRL PSD

Summer Precipitation in Western US

- Issues with inadequate representations and simulations of Atmospheric Dynamics (e.g. monsoonal flows) & Teleconnections

"Confidence in projections of [North America] monsoon precipitation changes is currently low"

IPCC AR5; Section 14.2.3.1

Are CMIP5 projections more credible for the western US or regional scale projections in general?

- ✧ No obvious evidence or strong basis for that
- ✧ Greater complexity does not translate into greater credibility – **range of projection uncertainty still similar**
- ✧ In general, large similarities between CMIP3 and CMIP5 projections – particularly at large scales

CMIP5 vs CMIP3: Implications for Managers

Do they need to start over?

No

Can they integrate the new information into planning they've already done?

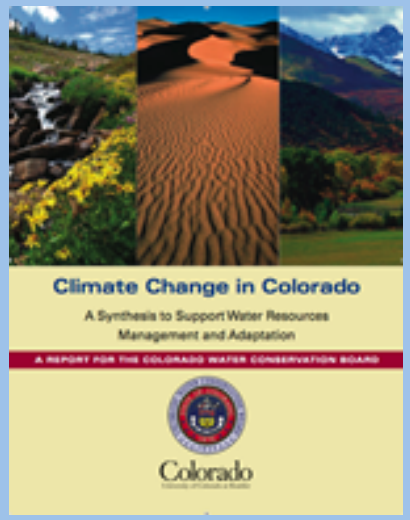
Yes

Can they stand by their vulnerability assessments which used CMIP3 projections?

Yes, but can certainly add to it

Good news if you have planned for a "hot-dry" future scenario of CMIP3

Coming soon….



CWCB/WWA *Climate Change in Colorado* report 2014

- The historic record of Colorado's climate
- About climate models, emissions scenarios, and downscaling
- The attribution of significant climate trends and events (including drought) to climate change
- **Projections of Colorado's climate and hydrology**
- Implications of the changing climate for water resources and frameworks for adaptation planning

Source: Jeff Lukas, WWA

Thank you

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