A Climate Change Perspective on Surface Water Availability for Los Angeles

Alex Hall
Professor, UCLA Dept. of Atmospheric and Oceanic Sciences
Director, Center for Climate Change Solutions

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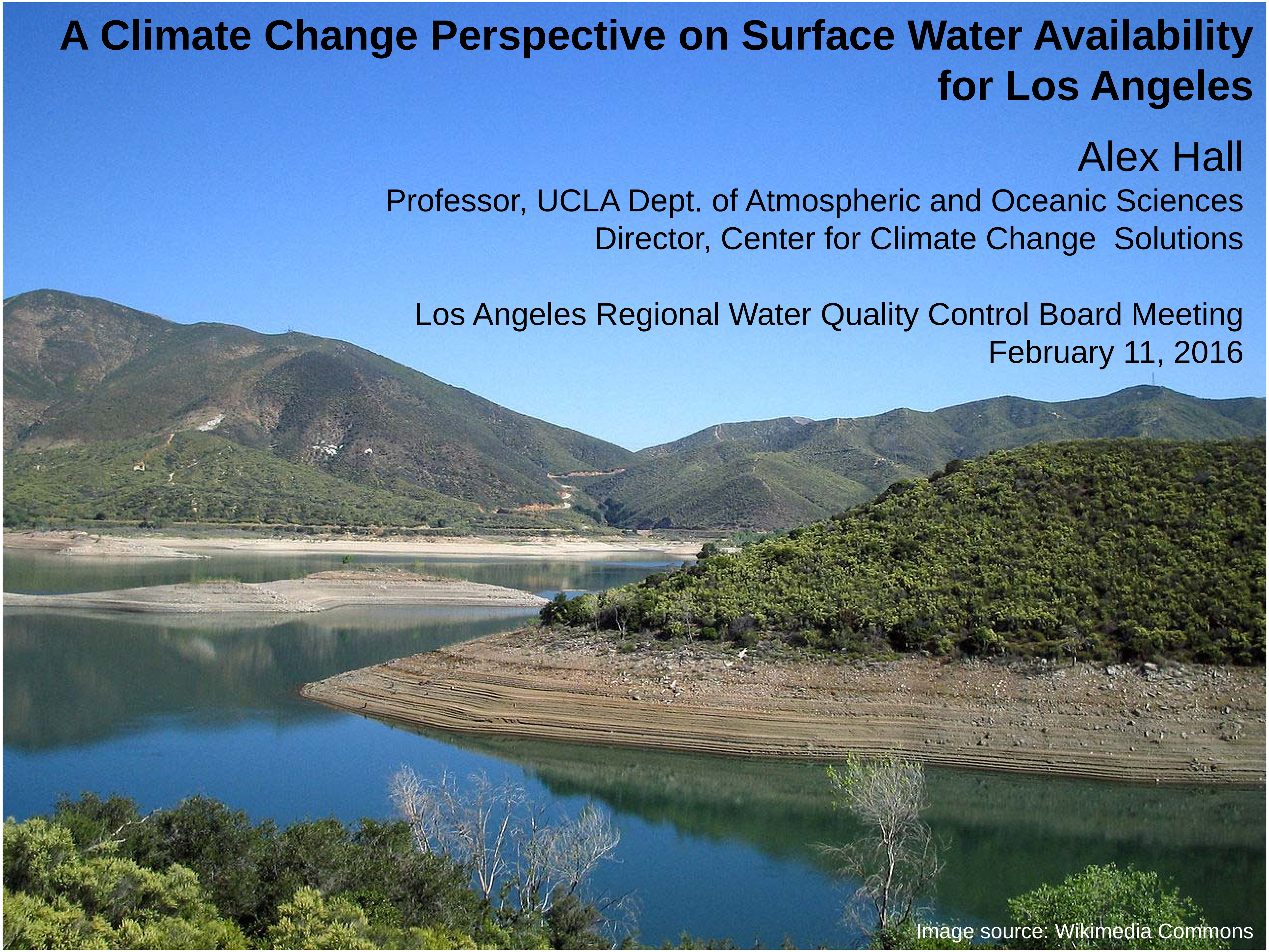

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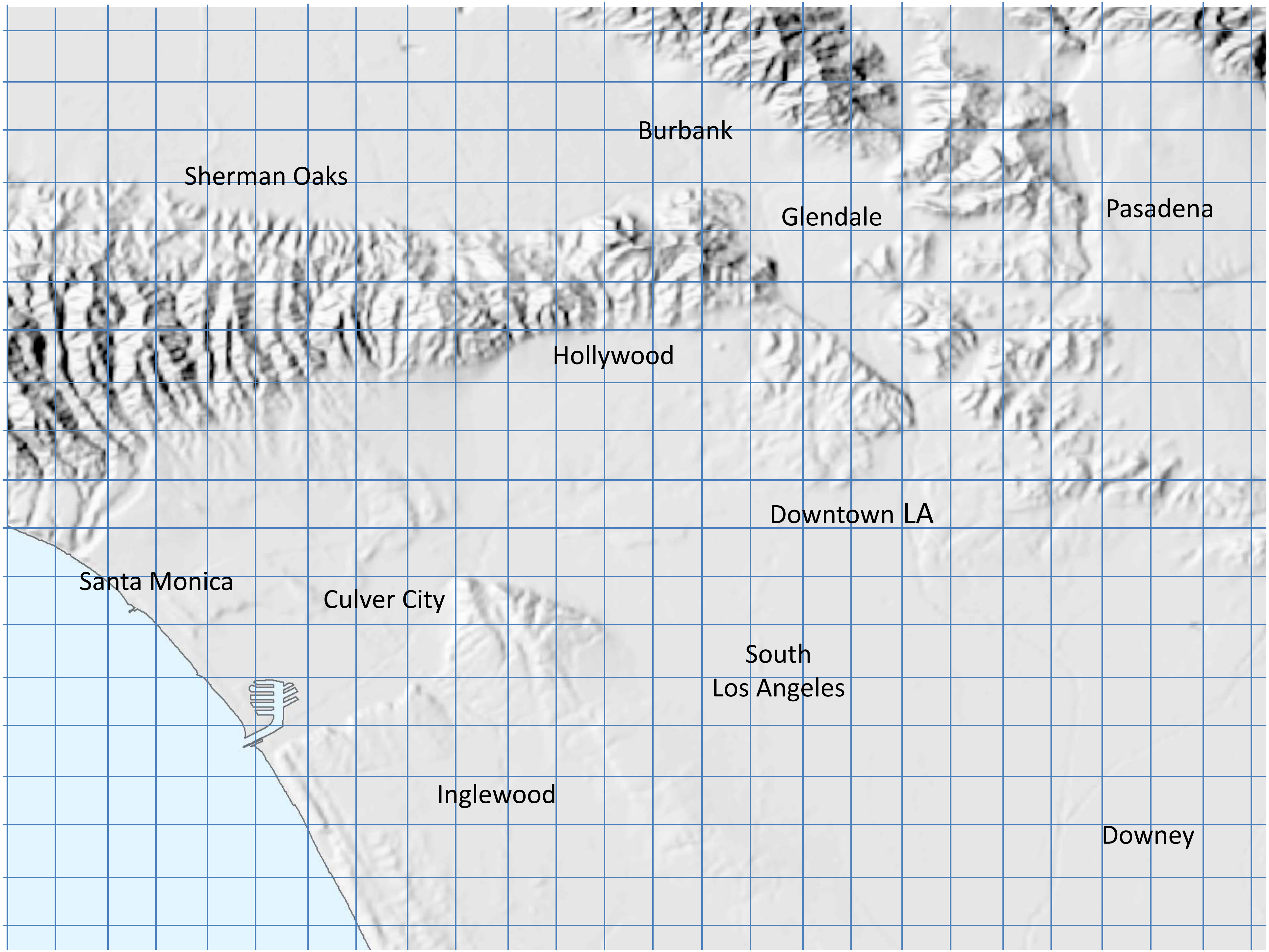
Understanding climate change on a policy-relevant scale

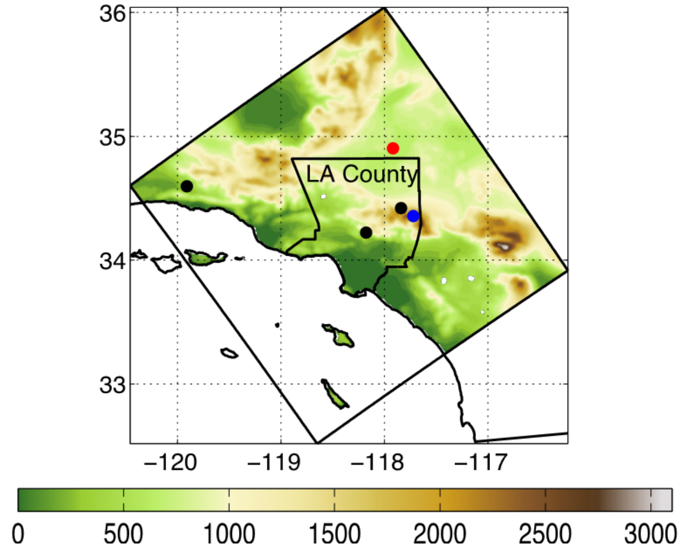
- Detailed projections of future climate change impacts can start crucial conversations about adaptation and mitigation.
- Our best tools for projecting future climate — global climate models (GCMs) — are too low in resolution to capture what happens in a region with complex topography, such as the Los Angeles region or the Sierra Nevada.
- Downscaling techniques help us regionalize GCM information and get high-resolution projections of future climate.

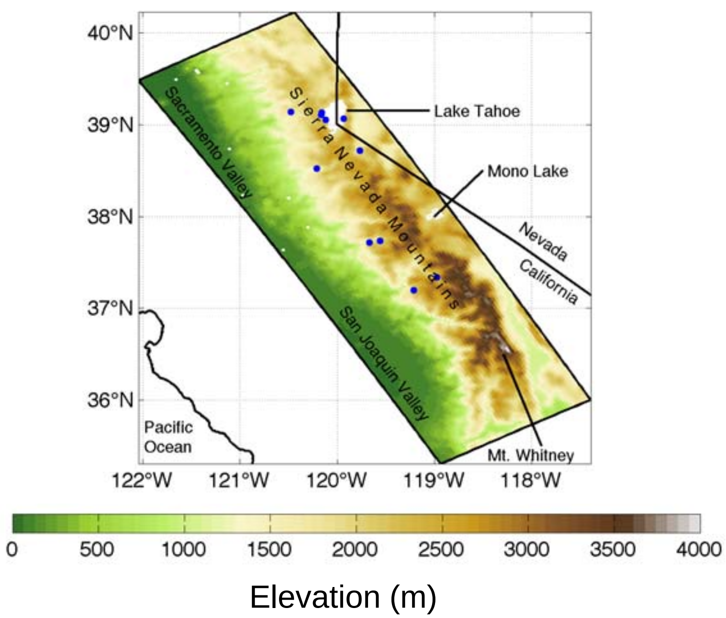

Palmdale
San Fernando
Valley
Ventura
San Bernardino
Downtown LA
Santa Monica
Long Beach


Burbank
Sherman Oaks
Glendale
Pasadena
Hollywood
Downtown LA
Santa Monica
Culver City
South
Los Angeles
Inglewood
Downey

Downscaling over LA and the Sierra Nevada

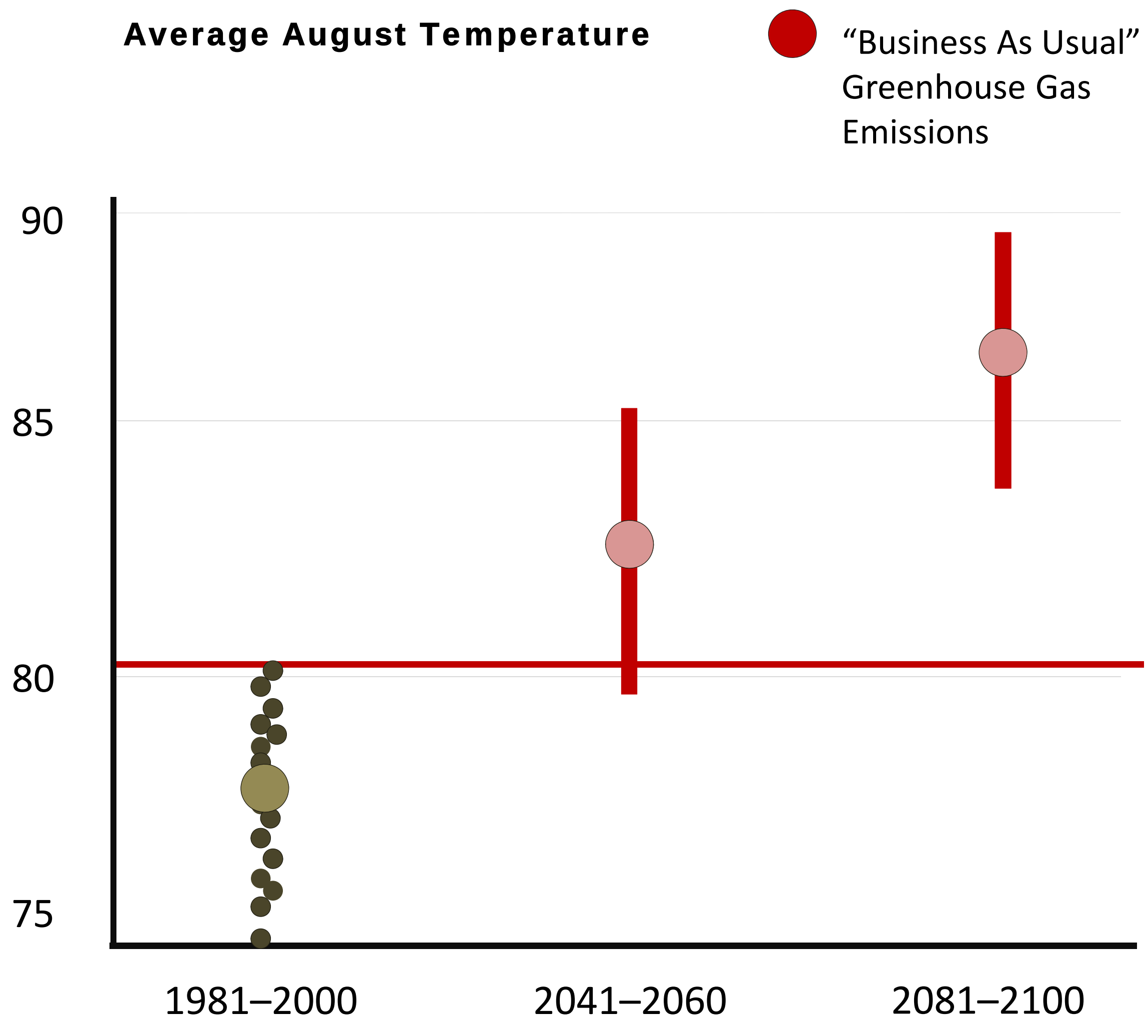
- Today's talk focuses on results from our study on climate change in LA.
- It also touches briefly on our Sierra Nevada findings.
- We developed a novel downscaling technique to create physically credible climate projections from full ensemble of 30+ latest-generation GCMs.
- We analyzed change in climate variables for 2041–2060 and 2081–2100, e.g.:
  - Temperature
  - Precipitation
  - Snowpack
  - Runoff





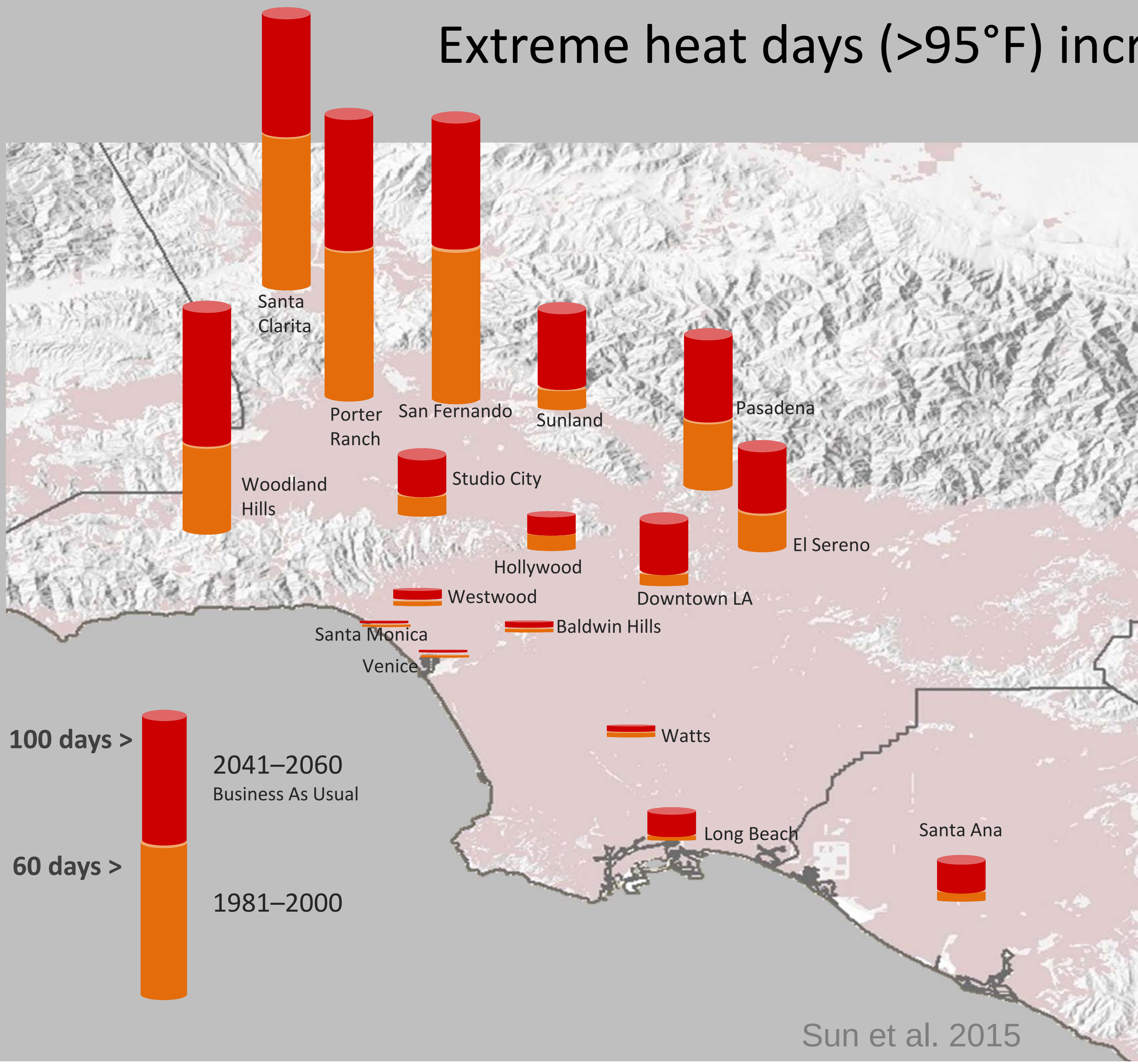
Changes in the Los Angeles Region

Temperatures increase across the LA region



Sun et al. 2015

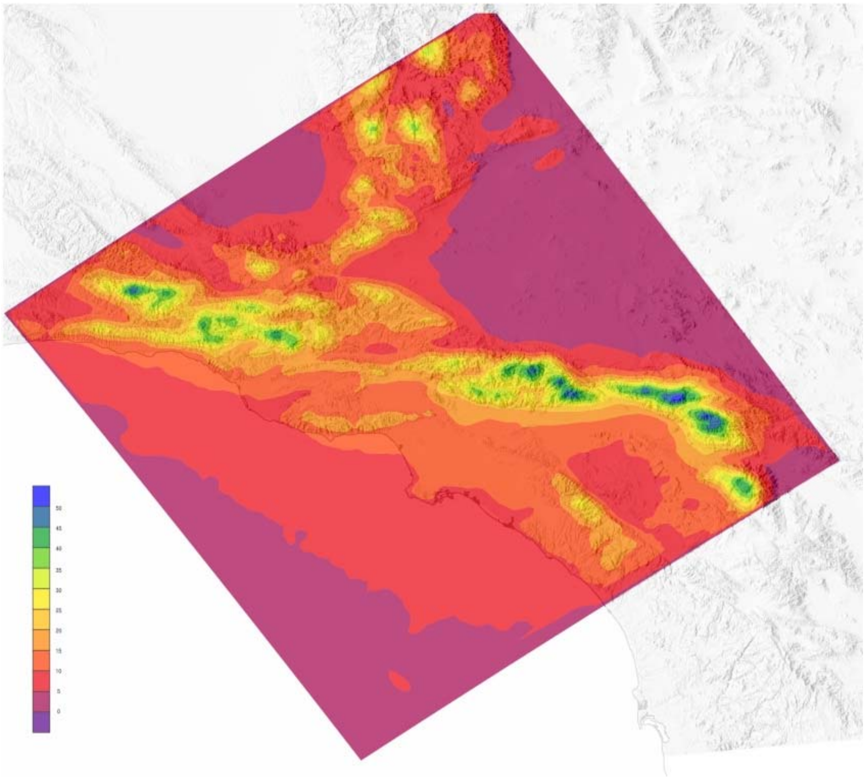
Extreme heat days (>95°F) increase



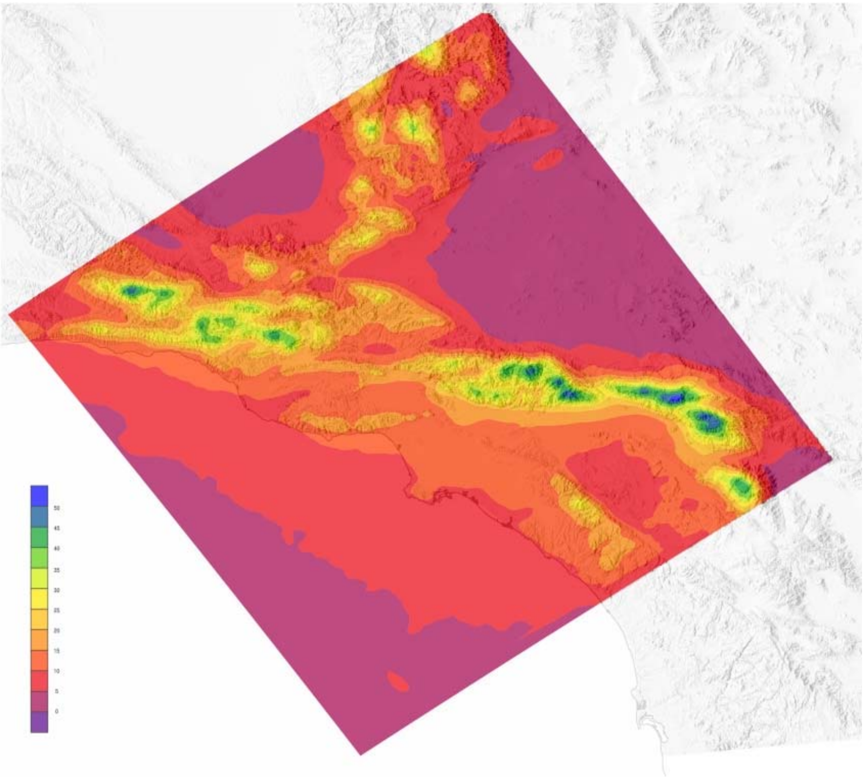
Sun et al. 2015

LA region precipitation totals don't change much

Average Dec–Mar Precipitation
1981–2000

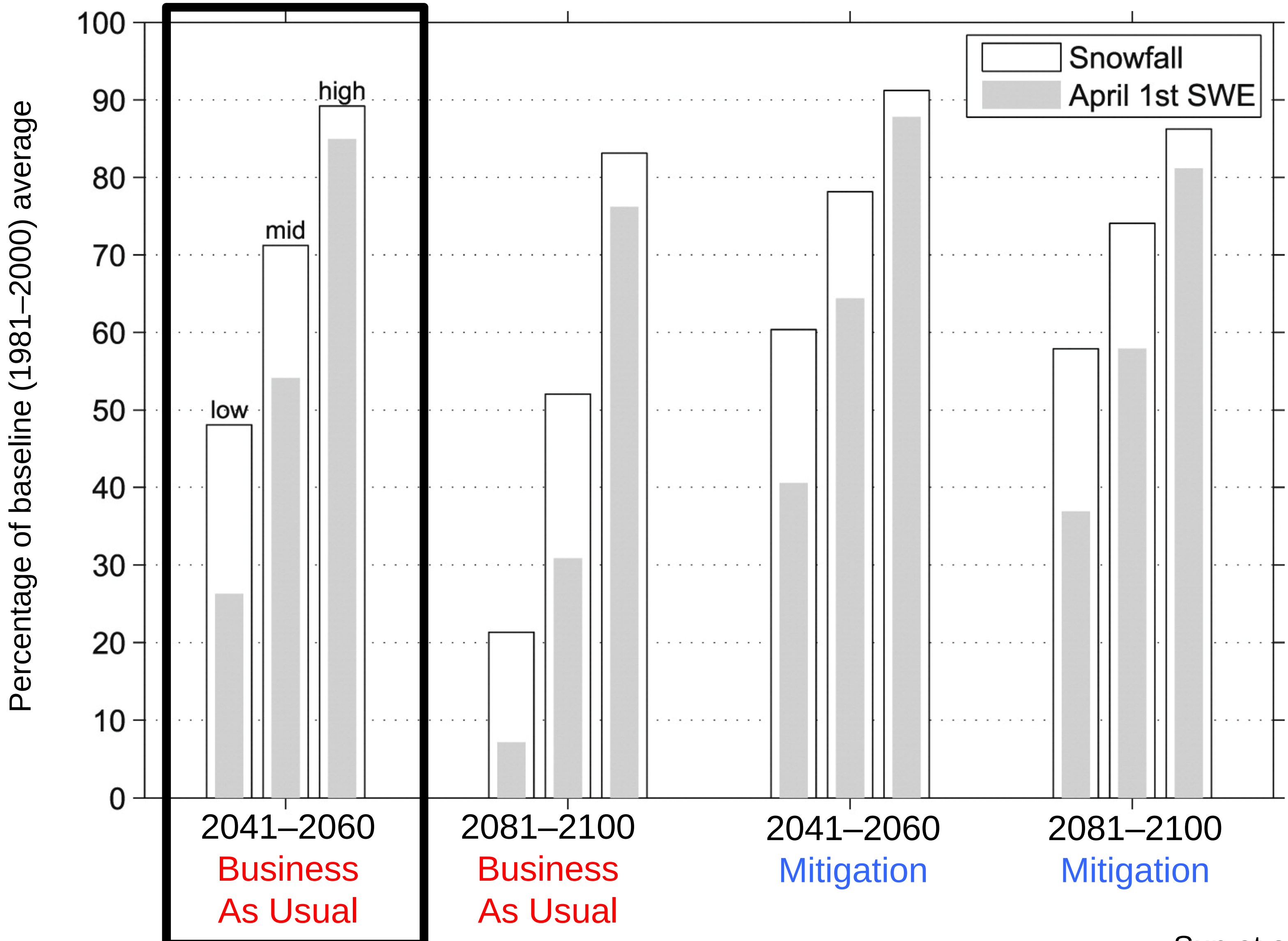


Average Dec–Mar Precipitation
2041–2060
Business As Usual



Berg et al. 2015

But due to warming, more precipitation falls as rain instead of snow, and snow melts faster



Sun et al. 2016a

Runoff timing and overall runoff are also largely unchanged in the LA region

Snowpack loss should change runoff timing. Warming increases potential evaporation from soils and plants dramatically, possibly reducing runoff. However, runoff timing and overall runoff are largely unchanged. This is because:

- The vast majority of LA's precipitation falls as rain instead of snow.
- In the current climate, soils are already very dry during the summer months. In a warmer climate, increases in evaporative losses are small because there is little moisture to lose.

Schwartz et al. 2015

But higher temperatures will affect LA's water demand

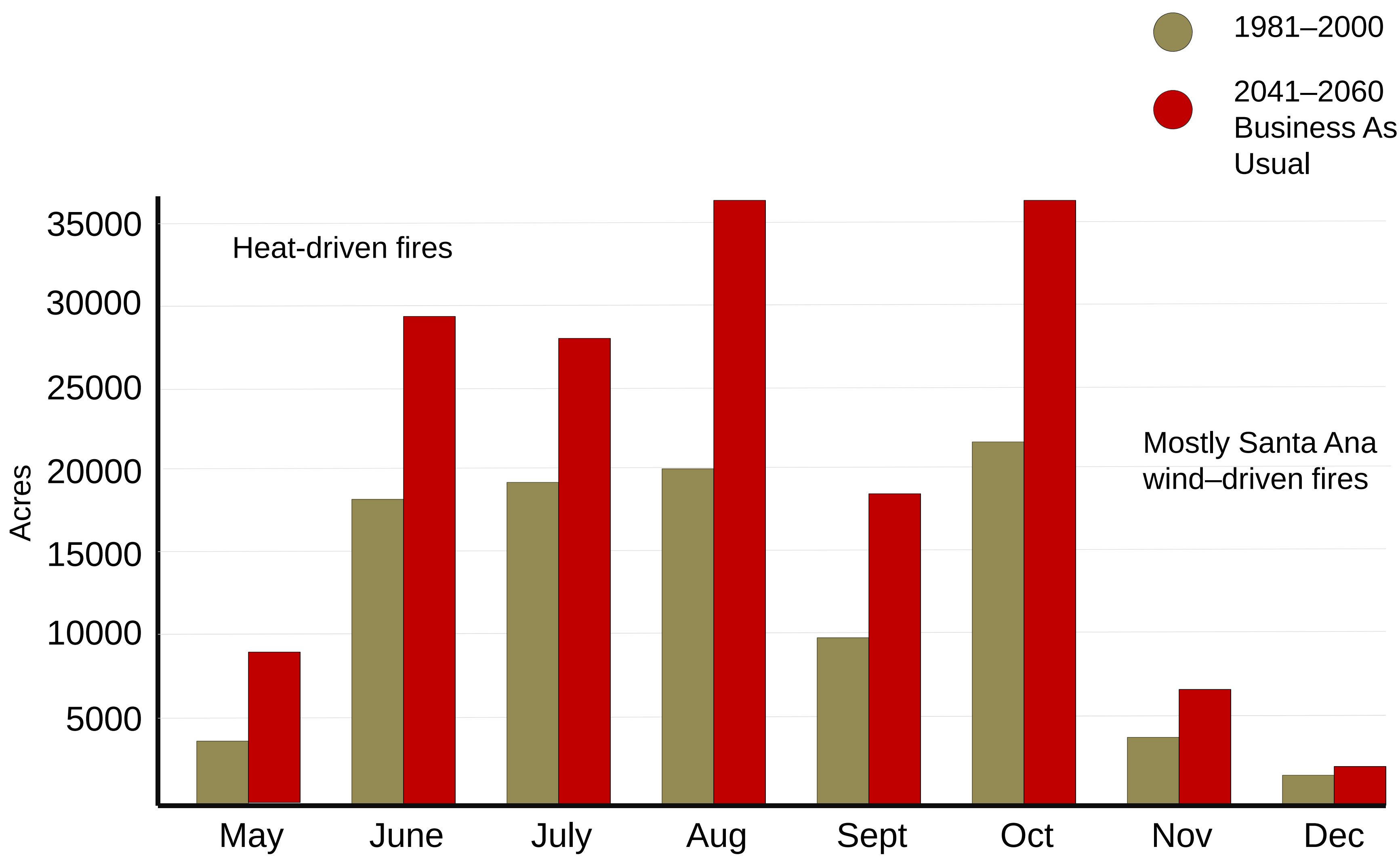
- When soils are saturated with water, evaporation from soil and transpiration from plants increase rapidly with temperature.

- This condition is met in heavily irrigated landscapes.

- Currently, more than half of residential water is used for outdoor watering of plants that are ill-suited for Southern California's climate.

- With climate change, outdoor landscaping that is not climate-appropriate will require significantly more water.

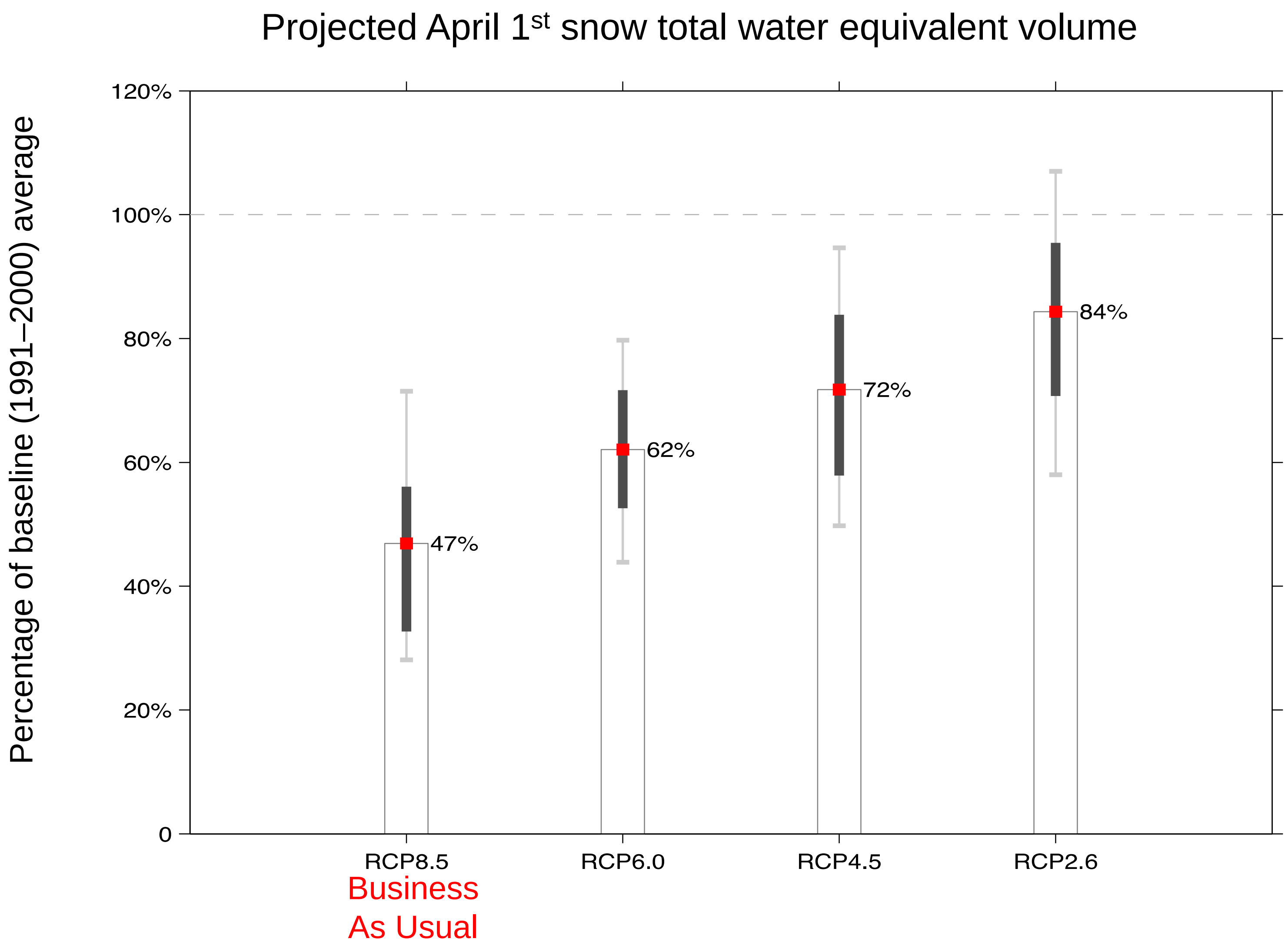
Area burned by wildfires will increase



Jin et al. 2015

Changes in the Sierra Nevada

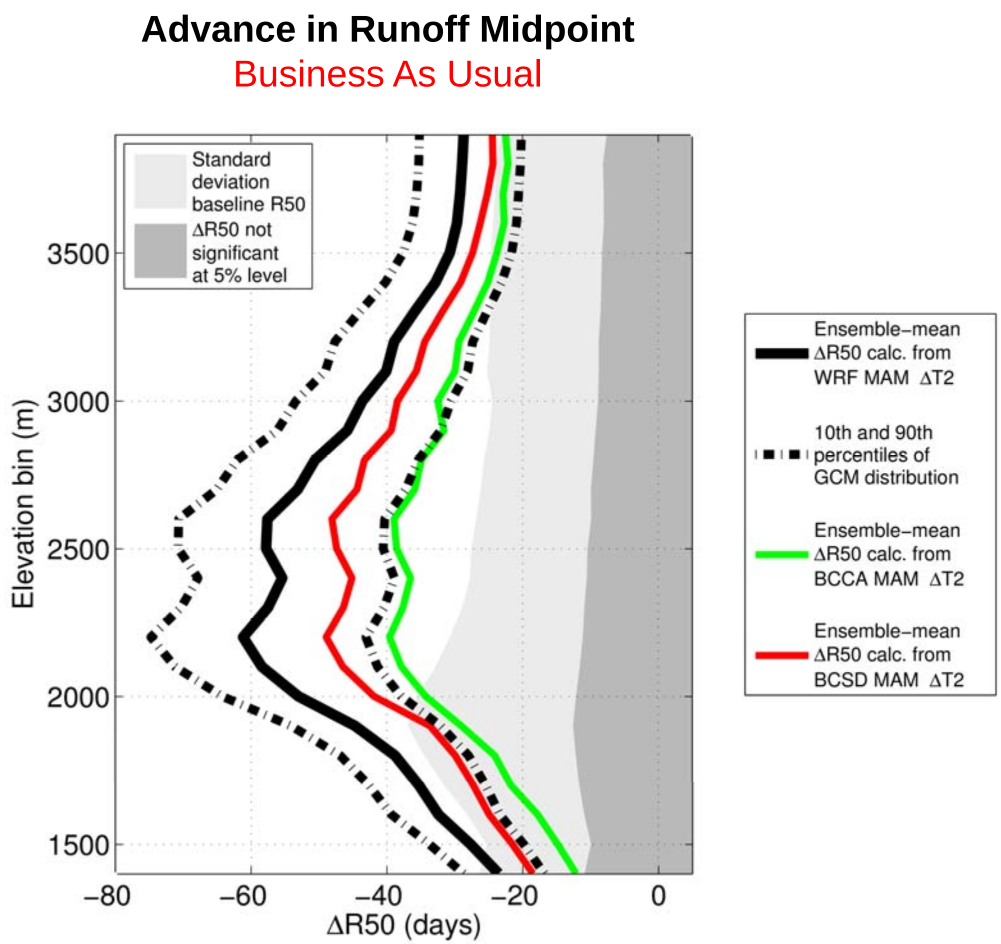
Sierra snowpack shrinks by end-of-century*



*Preliminary results, Sun et al. 2016b

Runoff occurs earlier in spring*

- More wintertime rain events and a smaller overall snowpack shift the timing of runoff earlier in the spring.
- At middle elevations, for example, the midpoint of total runoff occurs two months earlier in end-century business-as-usual projections.
- Our projections show greater advances in runoff timing than other downscaling methods used in past analyses.
- This is because our projections account for snow albedo feedback, a well understood phenomenon that exacerbates warming and further snow loss.



*Preliminary results, Schwartz et al. 2016

Implications and challenges

- In the Sierra Nevada, runoff timing changes may be larger than previously realized, and will pose significant challenges to water resource managers. It is unclear whether our water resources infrastructure and management regime can make up for the storage lost with snowpack.
- LA's local water resource appears much less vulnerable to climate change, and there is potential for greater stormwater capture. We need to quantify this potential.
- Given very likely changes in temperature and evaporation, we need to ask ourselves whether lawns are a smart use of water in Southern California.
- Increases in wildfire risk have implications for water quality, burned areas see reduced infiltration and increased mud and debris in runoff.
- We haven't yet answered some key policy-relevant questions, such as how the character of individual precipitation events may change.
- Additional expertise is needed to translate climate change information into impacts on human and natural systems, e.g., water resource infrastructure, economics, specific ecosystems.

References

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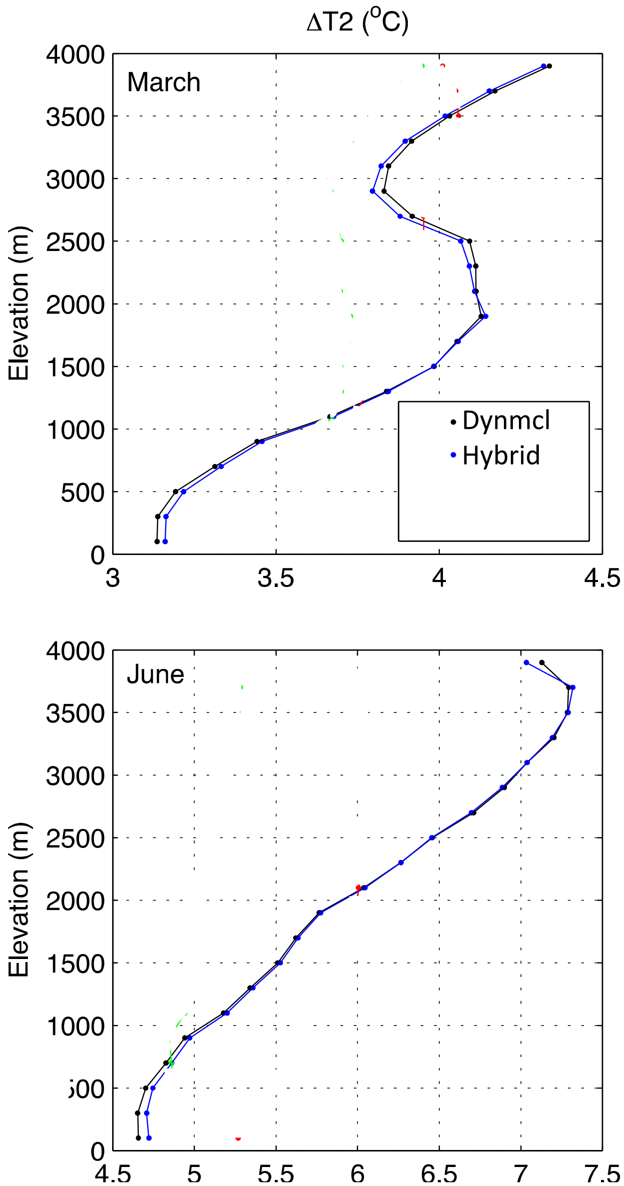
Image source: Wikimedia Commons

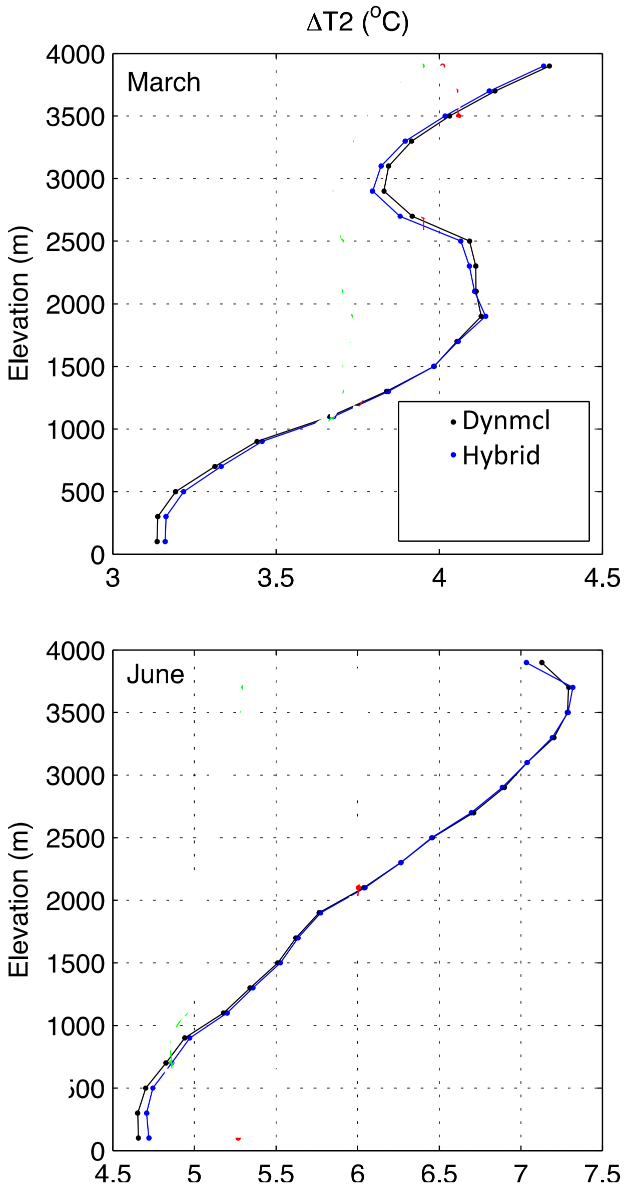
In the Sierra, warming varies by elevation*



- Higher temperatures mean a greater share of total precipitation falls as rain instead of snow.
- Where snow cover is lost, the exposed land surfaces absorb more solar radiation. This leads to greater local warming, and further local snow loss. This vicious circle is called snow-albedo feedback.
- Our hybrid downscaling method incorporates snow albedo feedback.
- Because of snow albedo feedback, by end-century under business-as-usual greenhouse gas emissions, mid-elevations warm more than other elevations during snow-covered months.

*Preliminary results, Walton et al. 2016

In the Sierra, warming varies by elevation*



- How do these projections stack up against other downscaled data products?

*Preliminary results, Walton et al. 2016

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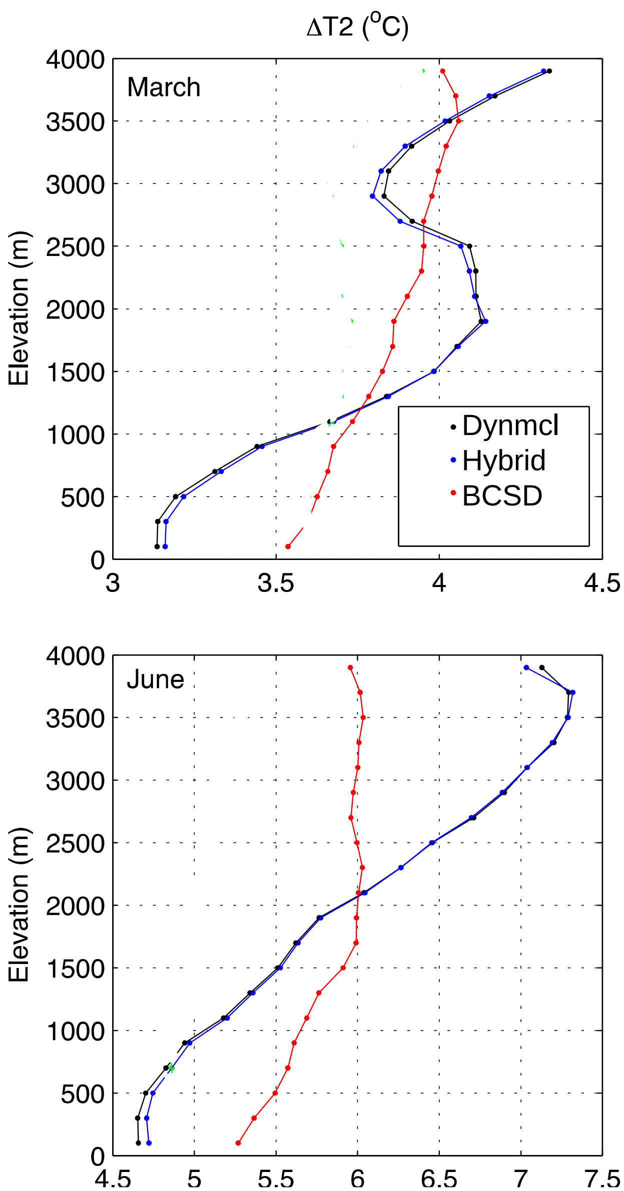
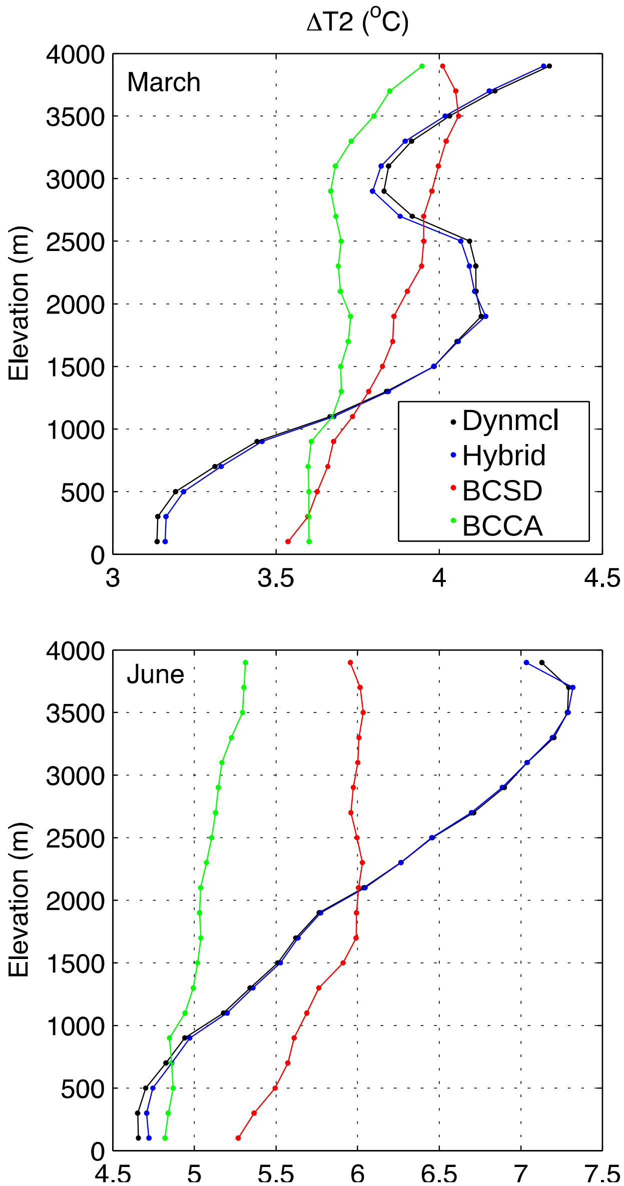


- **Here's** the warming given by BCSD, which may be one of the most commonly applied downscaling techniques.

*Preliminary results, Walton et al. 2016

In the Sierra, warming varies by elevation*

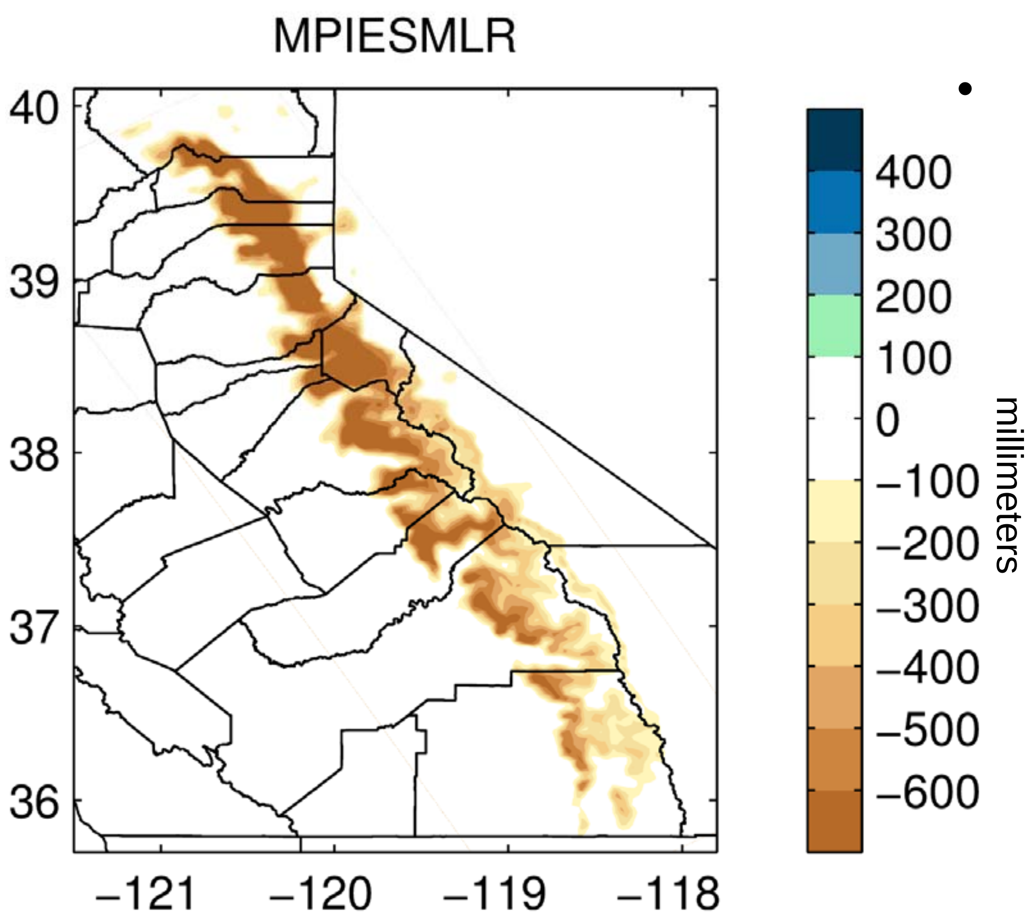


- **Here's** the warming given by BCSD, which may be one of the most commonly applied downscaling techniques.
- And **here's** the warming given by BCCA, another common technique.
- Neither BCSD nor BCCA captures the large variations in warming with elevation.
- In fact, both BCSD and BCCA produce "flat" warming projections in the Sierra Nevada, with little spatial structure.
- As a result, our projections show greater snow loss than previously projected.

*Preliminary results, Walton et al. 2016

Sierra snowpack shrinks by end-of-century*

2091–2100 April 1 SWE loss
Business As Usual



- This figure gives a sense of the spatial distribution of snow water equivalent loss throughout the Sierra.
- It shows dynamically downscaled output from one global climate model, which is close to the ensemble-mean result.

*Preliminary results, Sun et al. 2016b