Water Forward
Austin's Integrated Water Resources Plan
Task Force Meeting

December 6, 2016

Climate Change and Hydrology Analysis Presentation

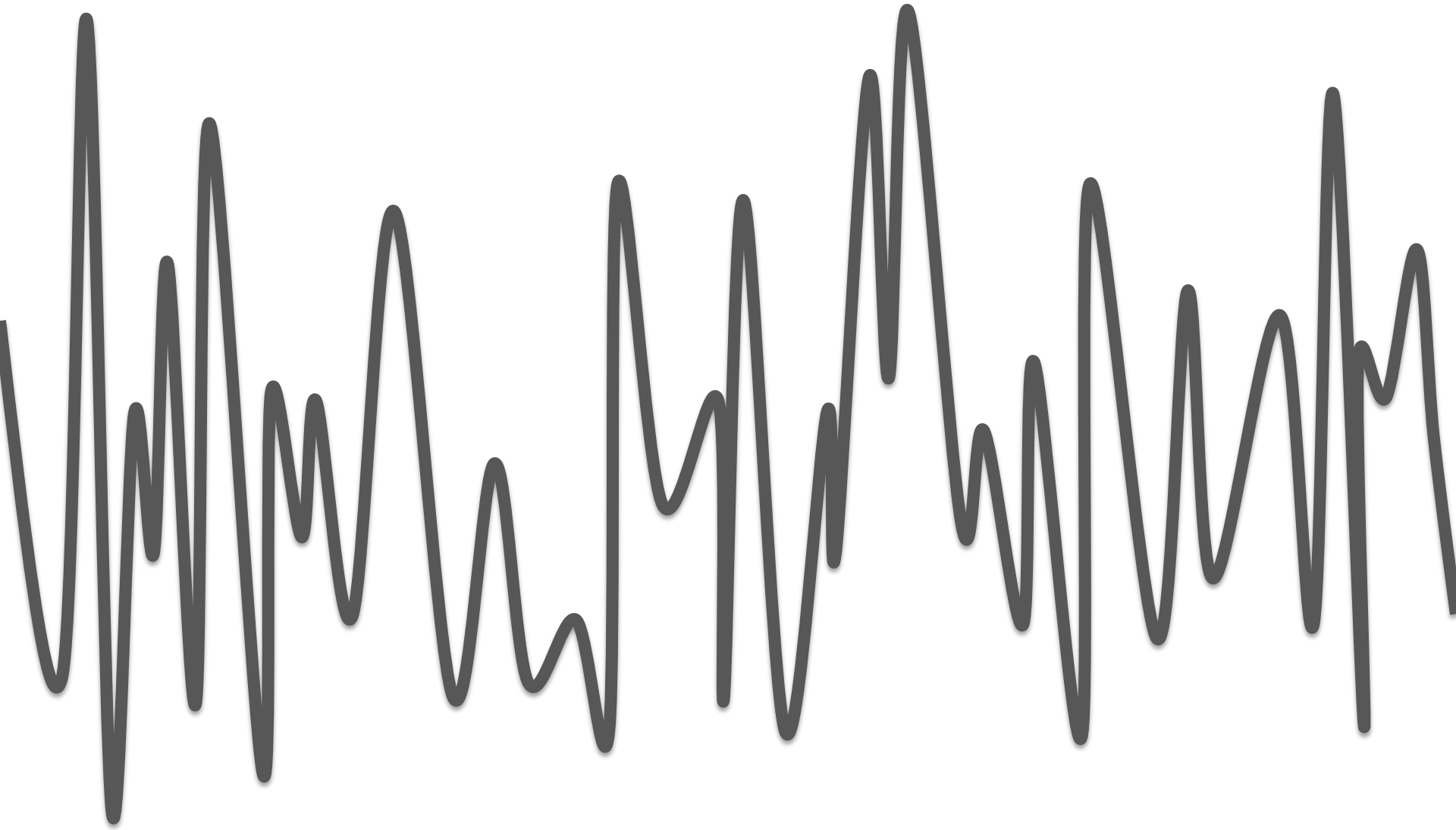
CLIMATE AND HYDROLOGY ANALYSIS FOR AUSTIN WATER

Katharine Hayhoe, Rodica Gelca and Anne Stoner

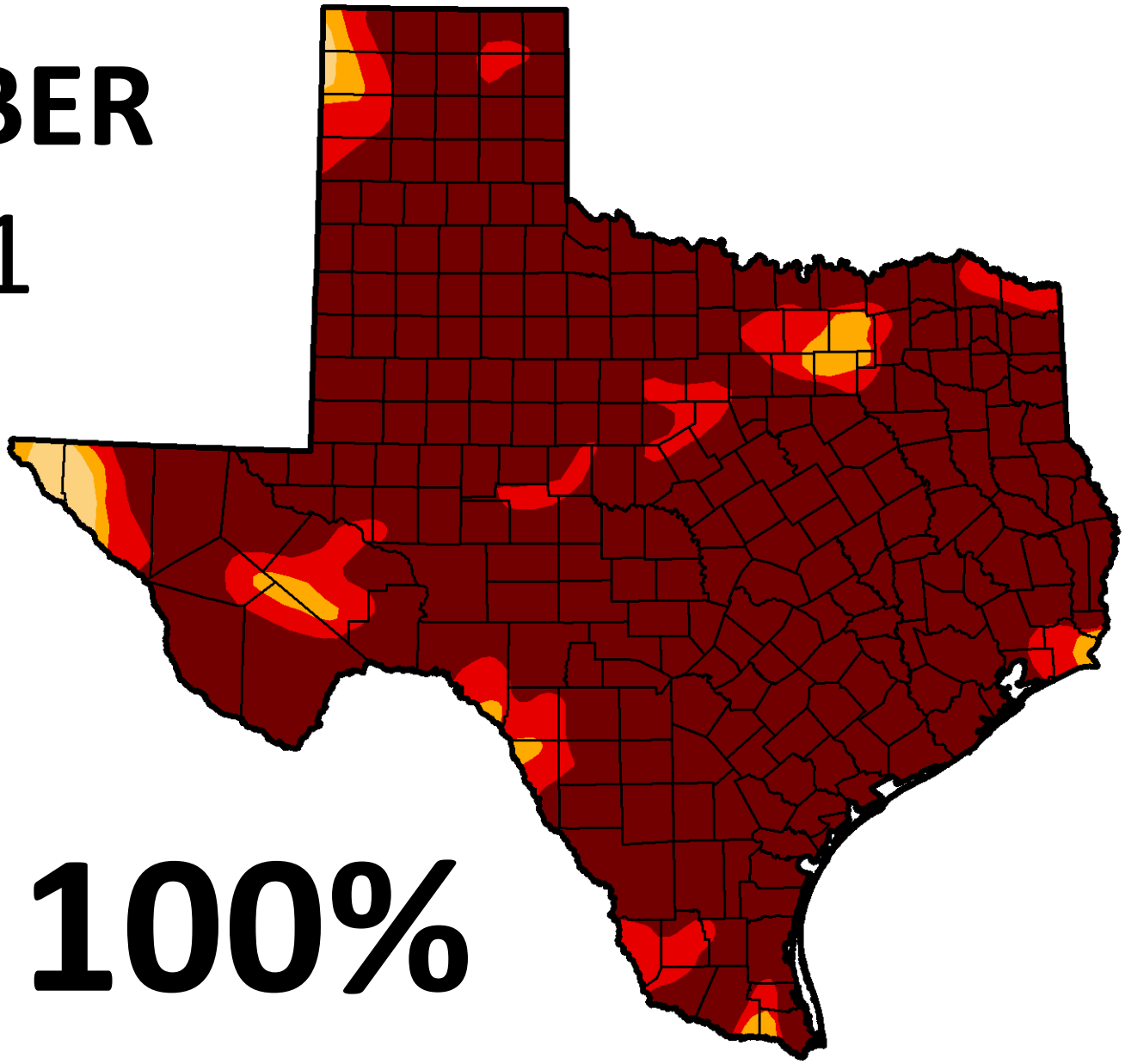
DECEMBER 6, 2016

NORMAL CLIMATE

TEXAS CLIMATE

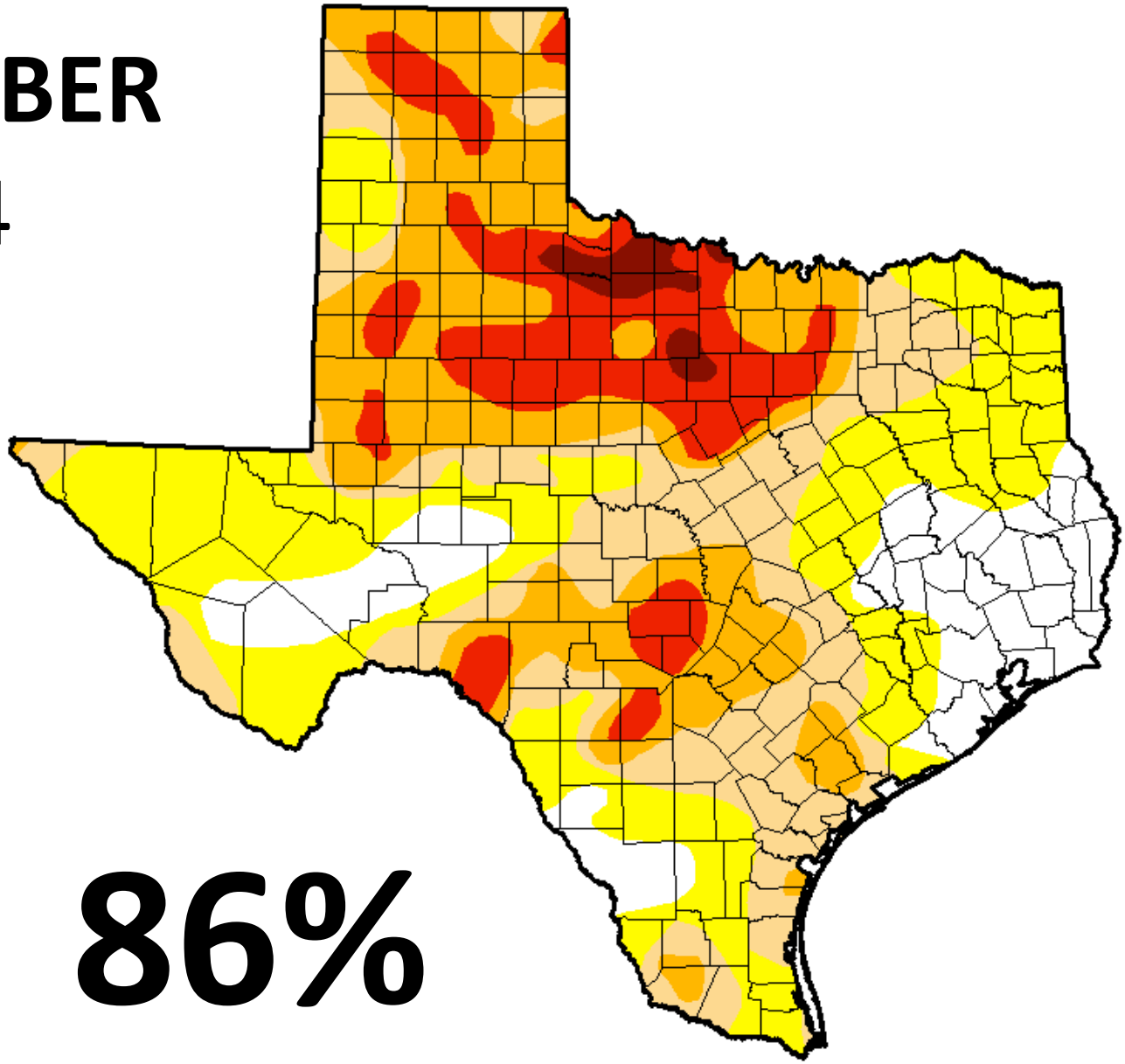


OCTOBER
2011



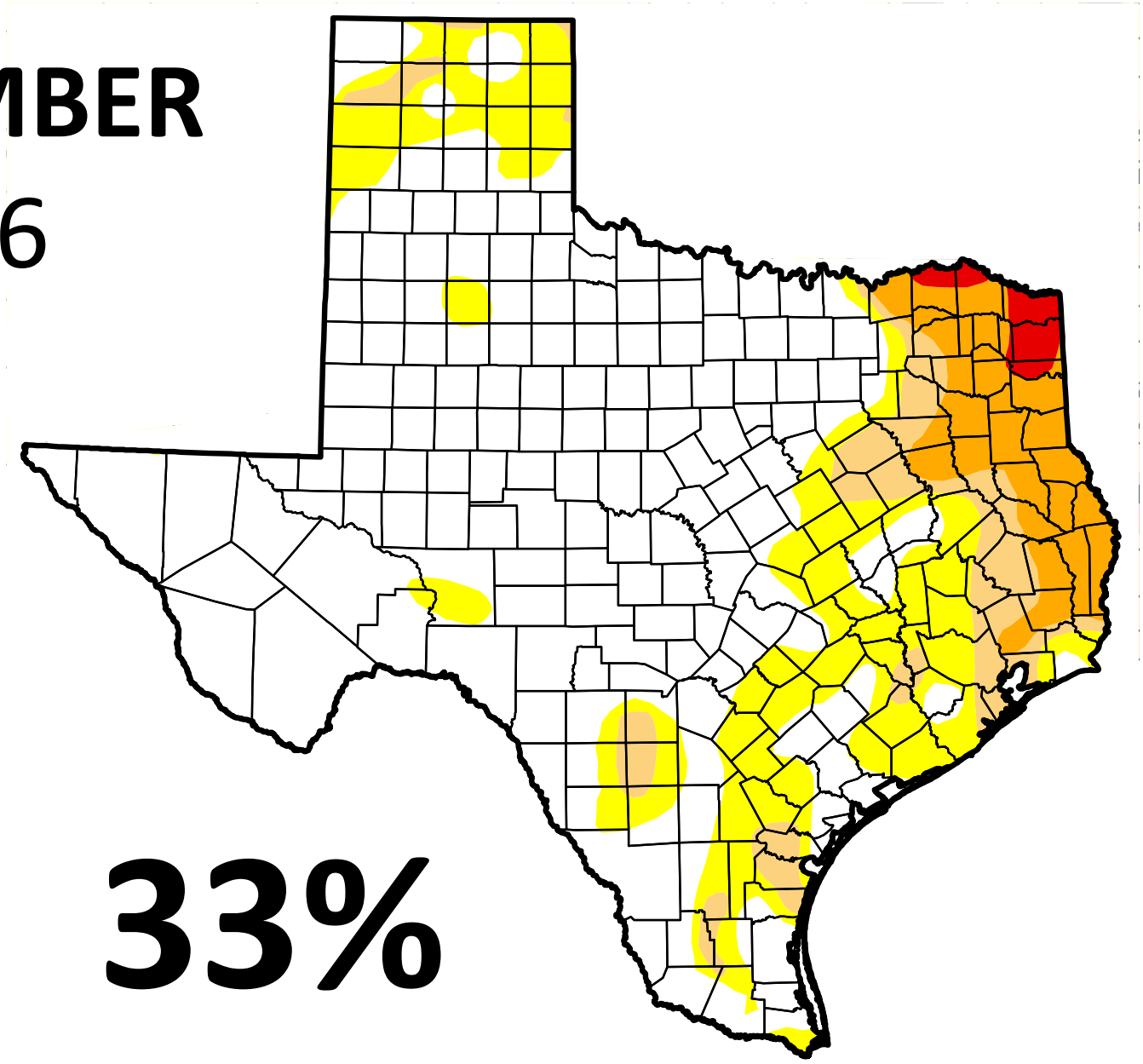
100%

SEPTEMBER
2014



86%

NOVEMBER
2016

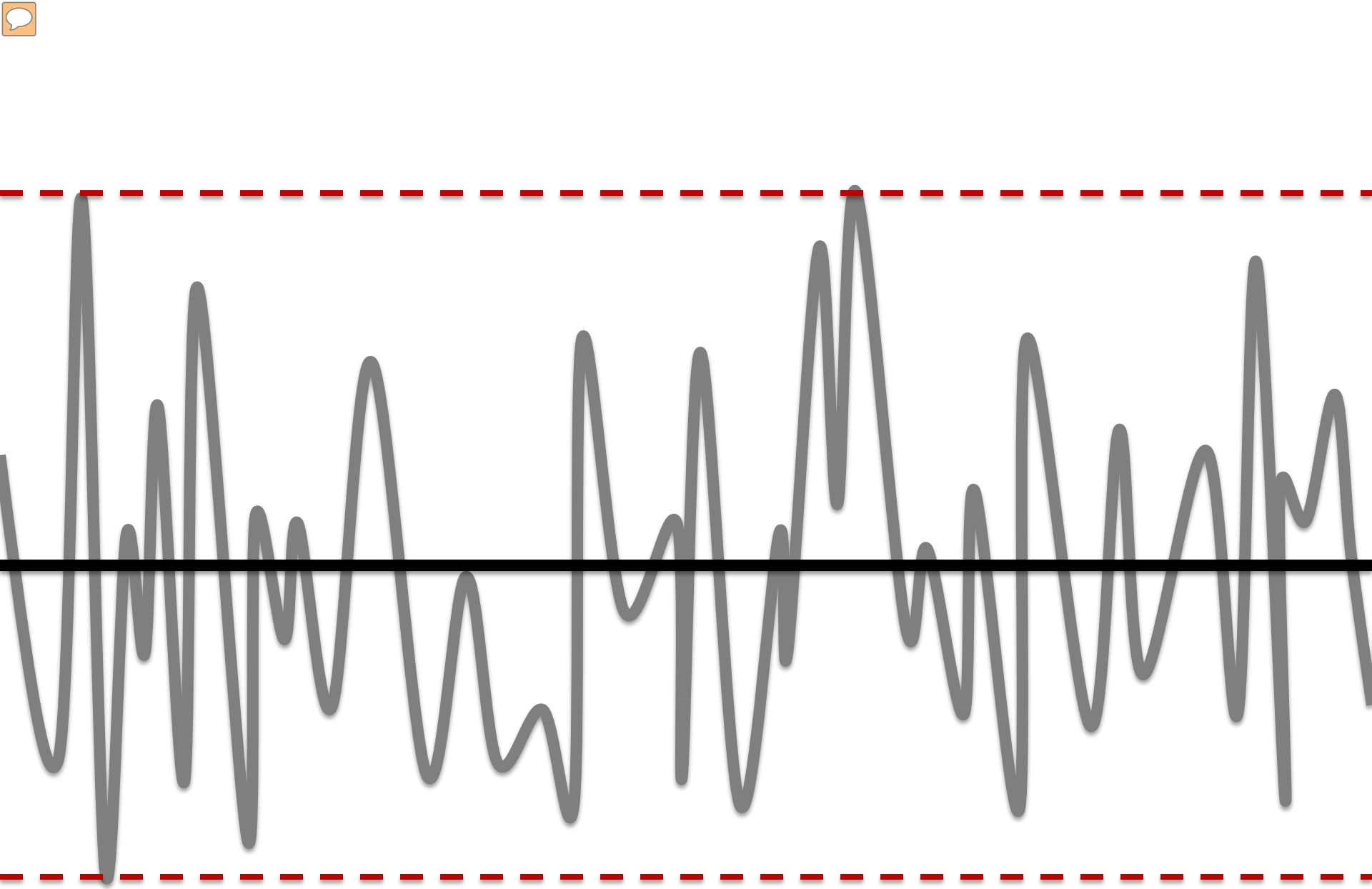


33%

WATER SCARCITY

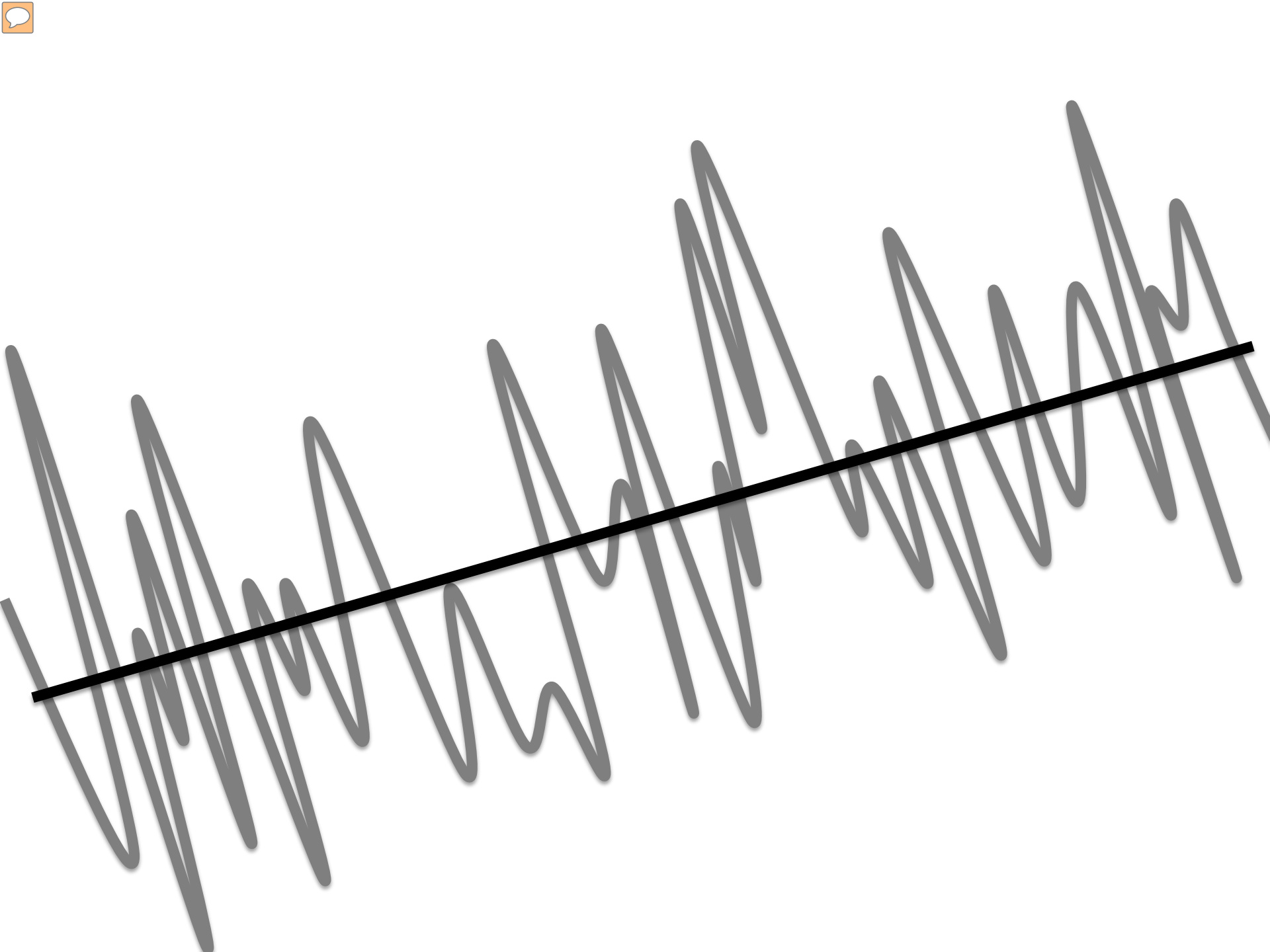
WILDFIRE

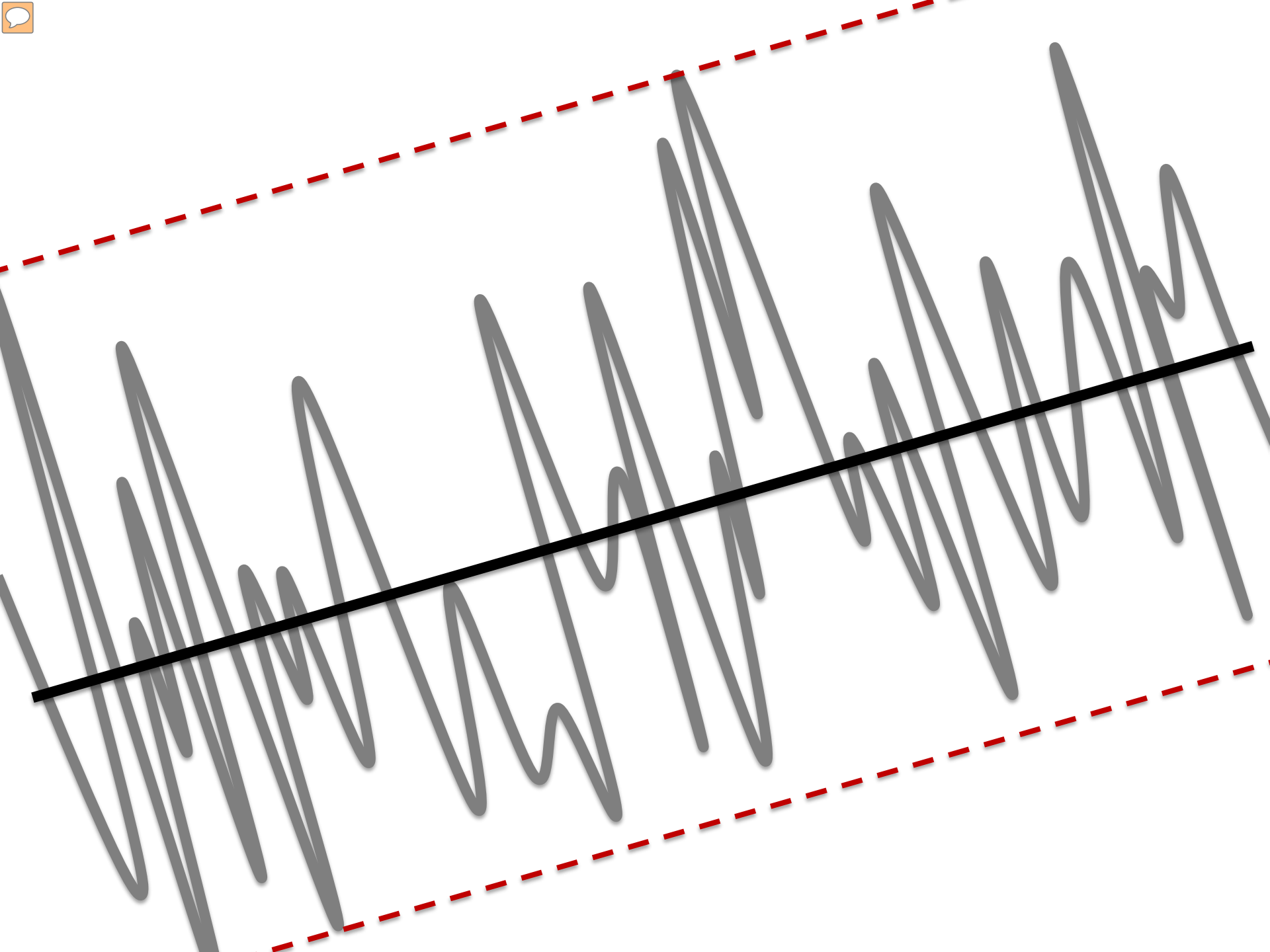
RECORD-BREAKING RAINFALL



87
84
Idalou
87
289
114
Lubbock
82

Planning for the future
based on the past
is like driving down the road
looking in the rear-view mirror.





CLIMATE ANALYSIS FOR AUSTIN

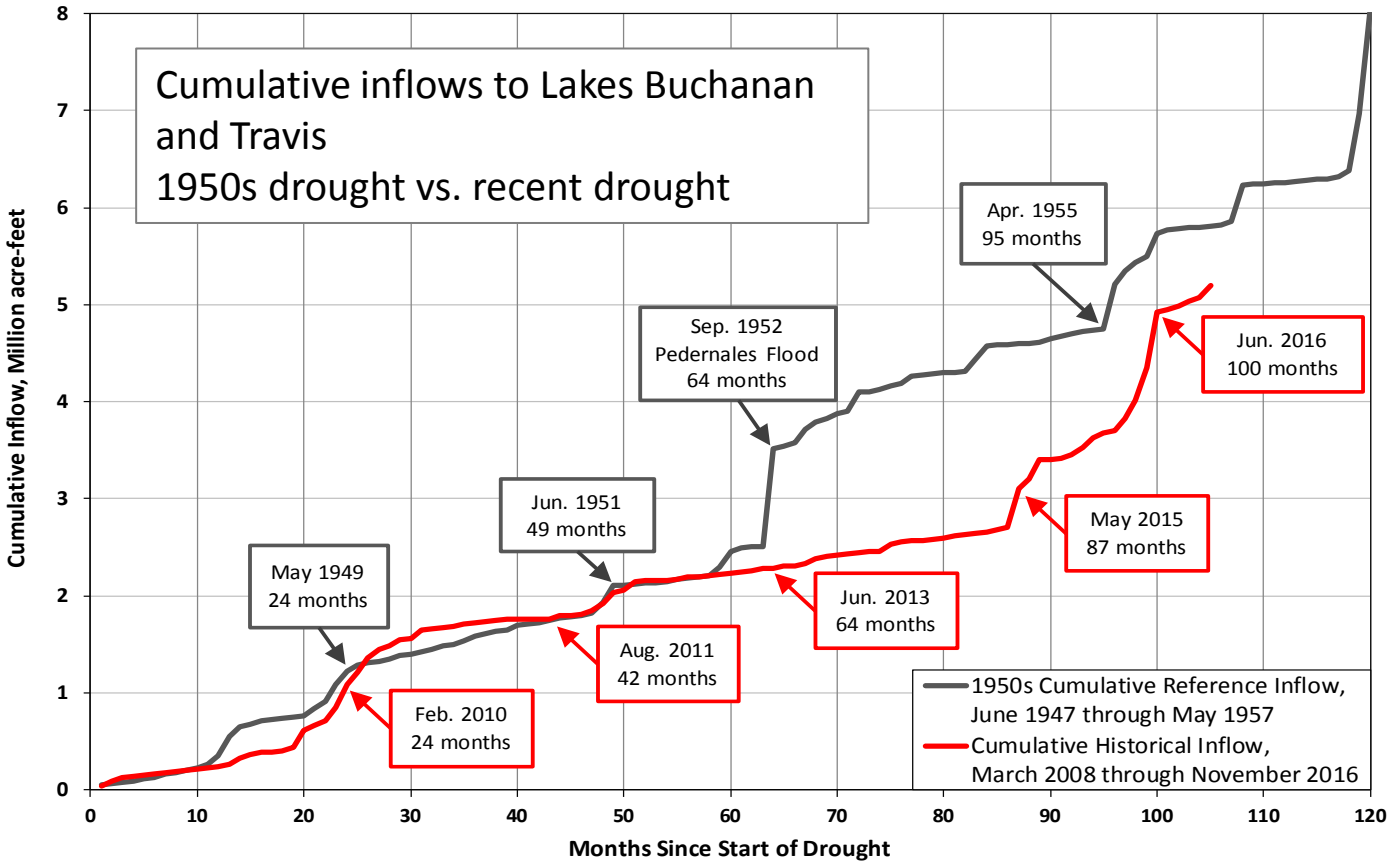
Our climate is already changing, consistent with larger-scale trends observed across the U.S. and the world.

In the future, in Central Texas, we expect:

- Increases in annual and seasonal average temperatures
- More frequent high temperature extremes
- Little change in annual average precipitation
- More frequent extreme precipitation and more drought conditions in summer due to hotter weather

MOTIVATION

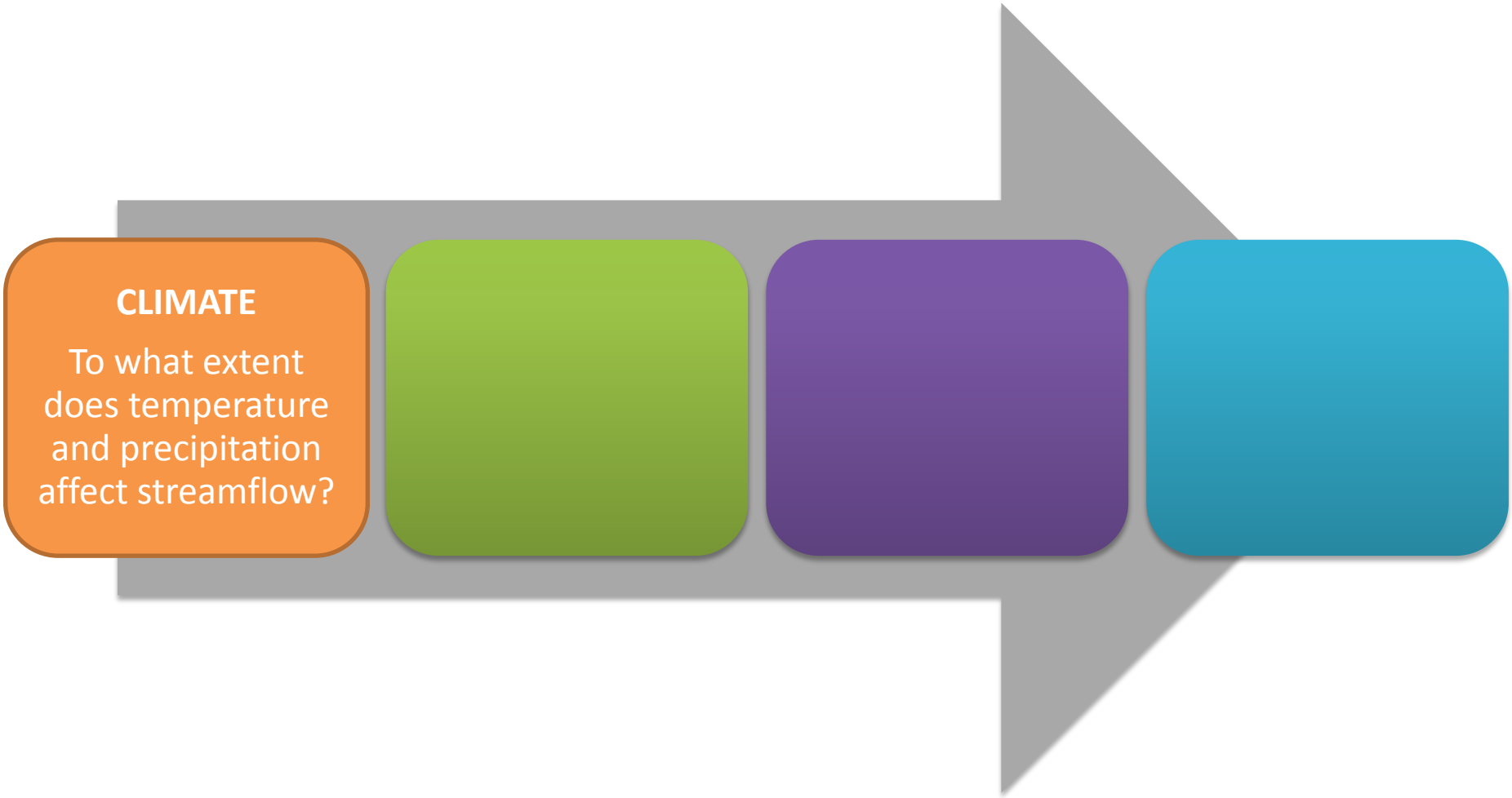
Inflows during the most recent drought were much lower than during the 1950s drought.

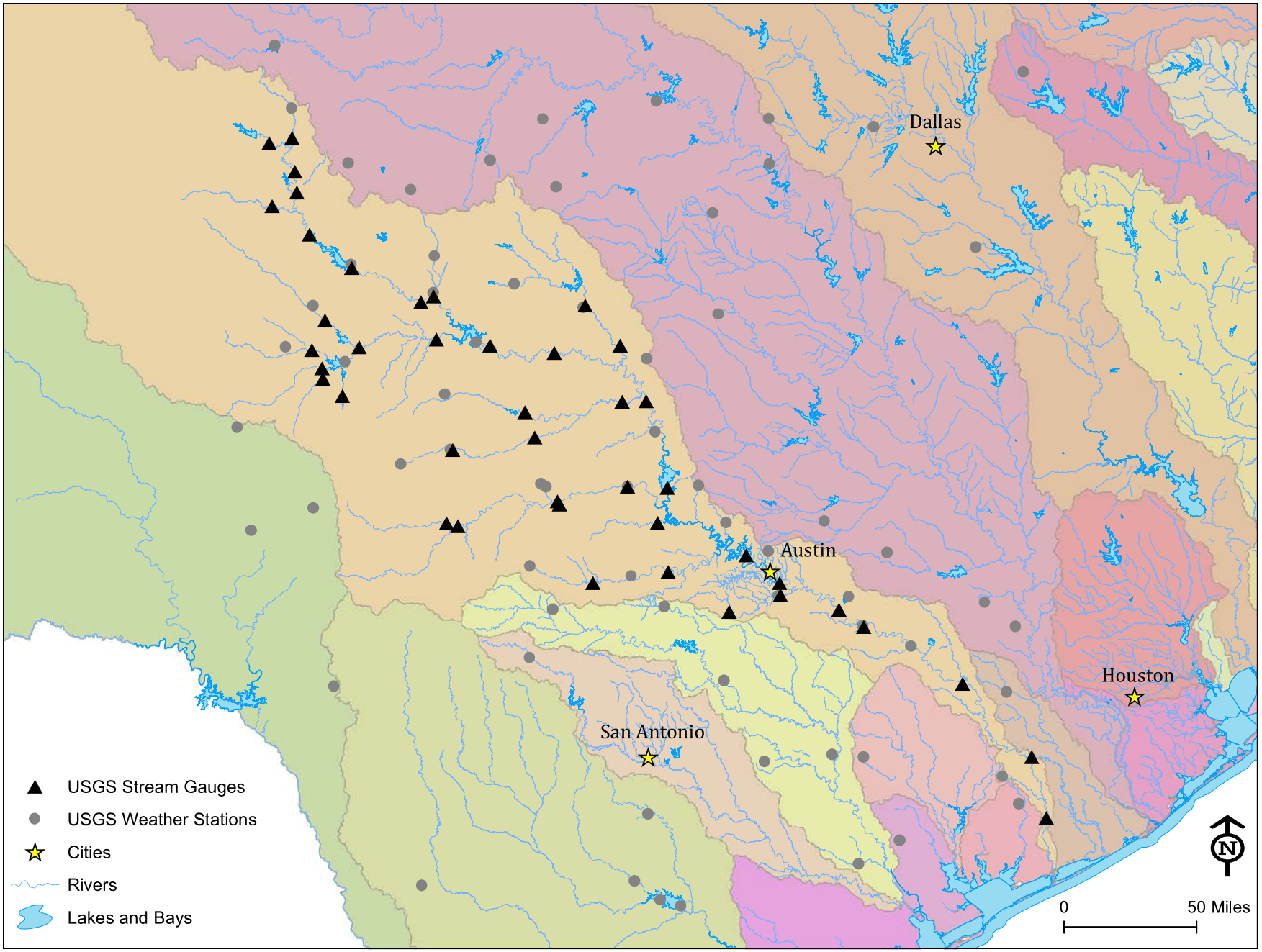


MOTIVATION

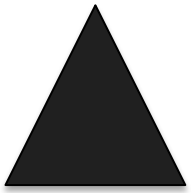
Inflows during the most recent drought were much lower than during the 1950s drought.

This study seeks to develop hydrologic projections to evaluate how a changing climate might affect future water supply in Austin and how to plan for it.

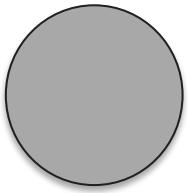

CLIMATE
To what extent does temperature and precipitation affect streamflow?


Dallas
Austin
Houston
San Antonio
USGS Stream Gauges
USGS Weather Stations
Cities
Rivers
Lakes and Bays
N
0
50 Miles

OBSERVED DATA



STREAMFLOW GAUGES



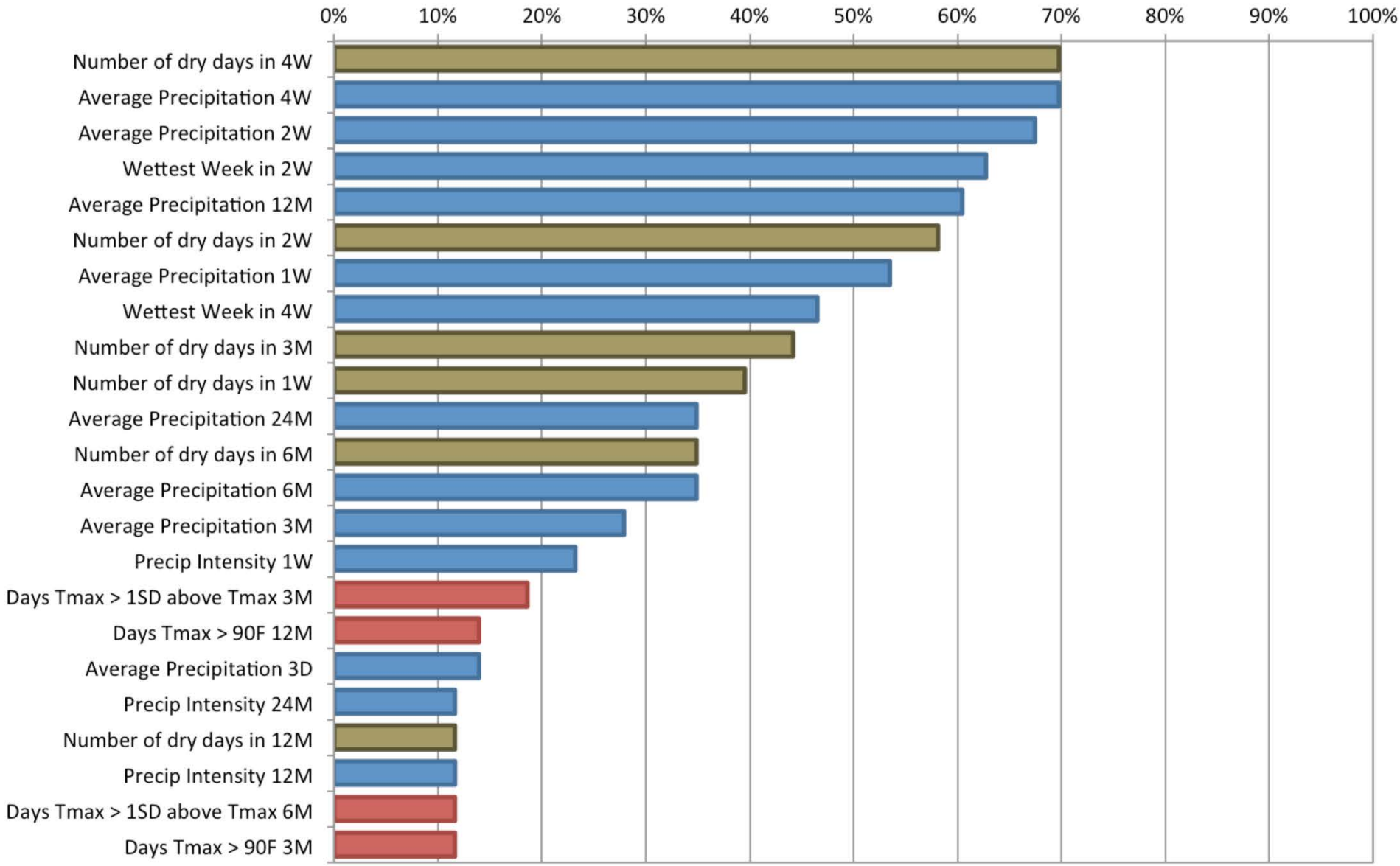
WEATHER STATIONS

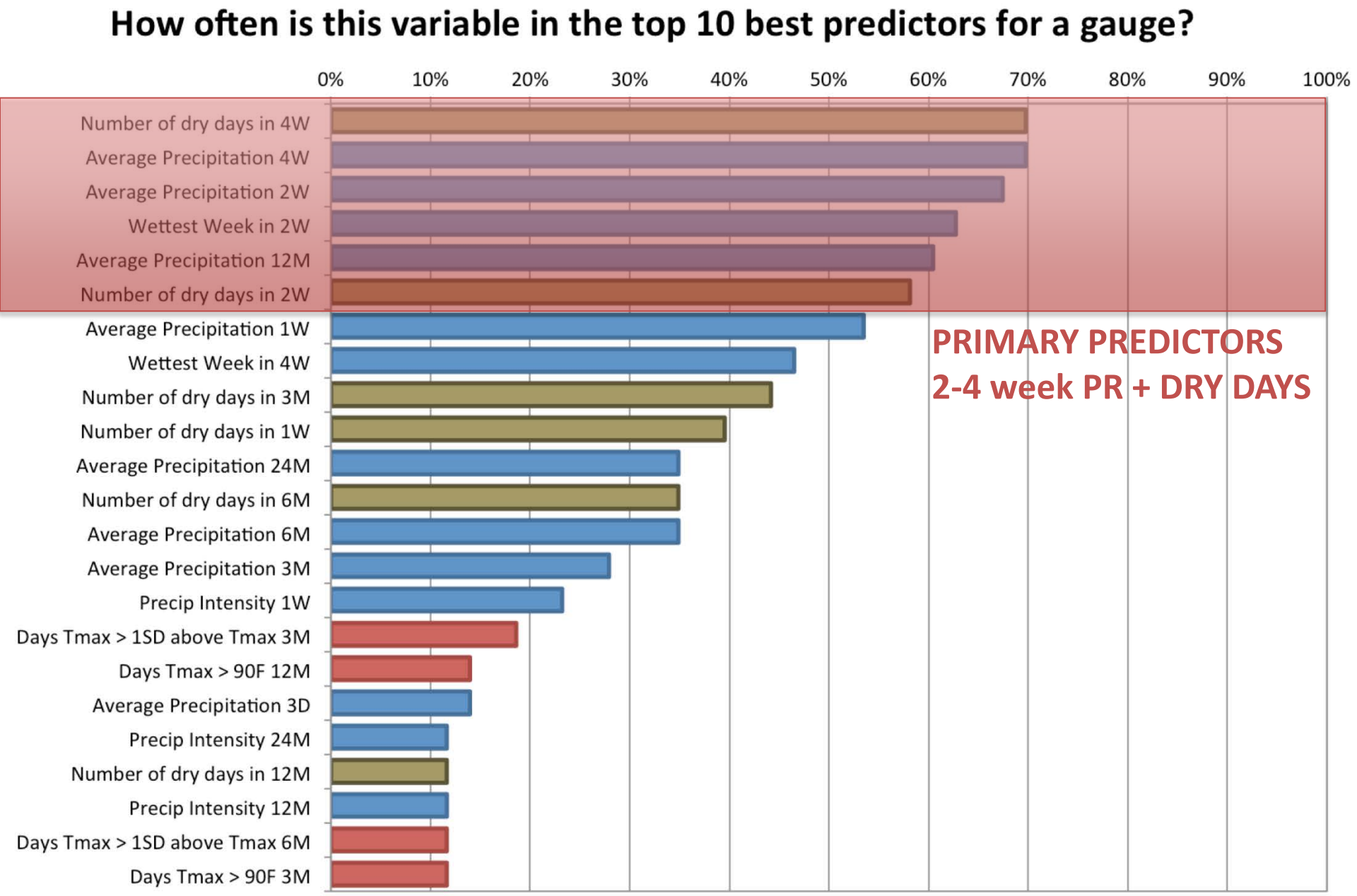
Daily streamflow, scaled to match naturalized monthly flows

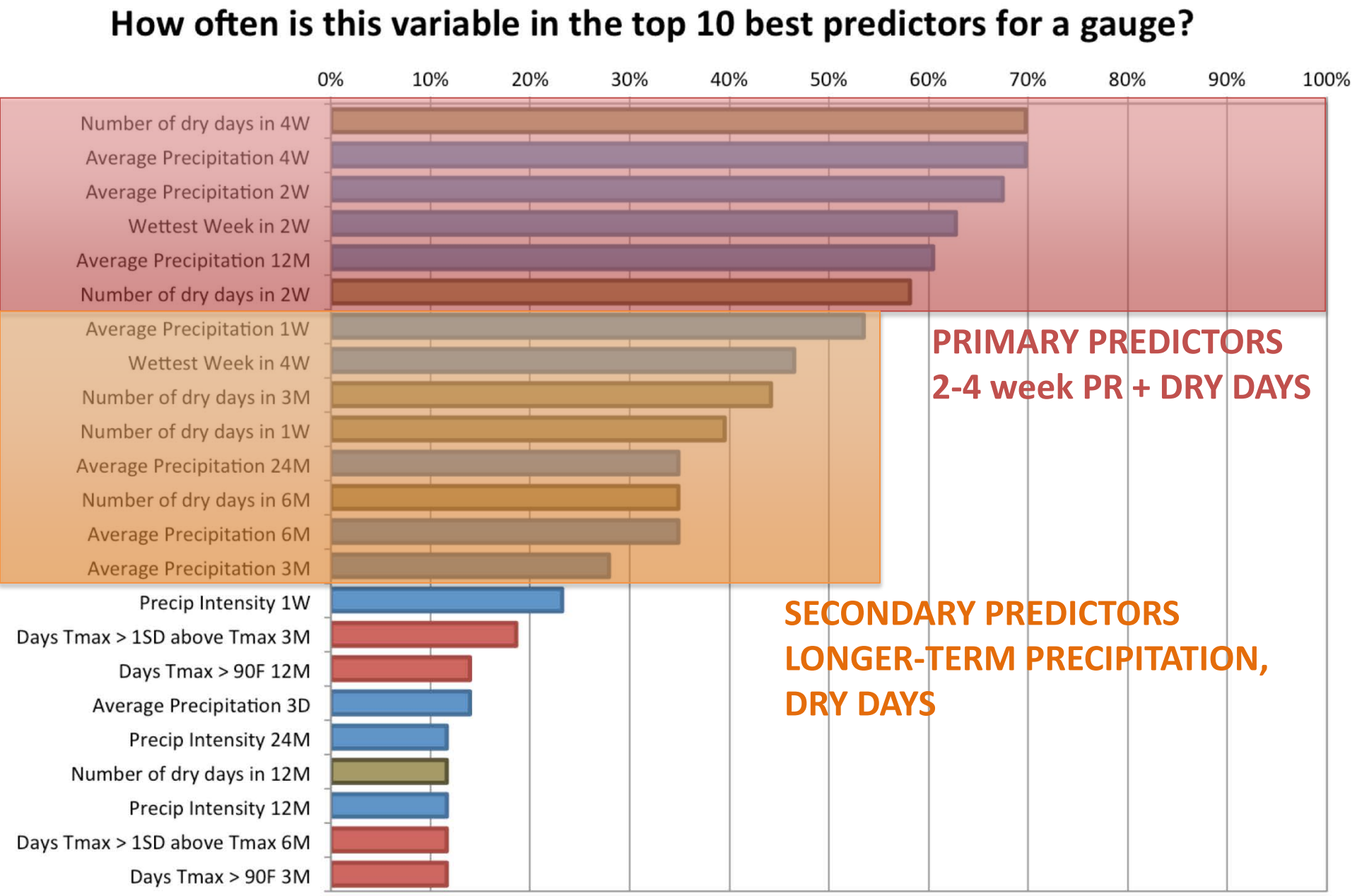
Daily temperature and precipitation

1940 - 2013

How often is this variable in the top 10 best predictors for a gauge?




How often is this variable in the top 10 best predictors for a gauge?
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Number of dry days in 4W
Average Precipitation 4W
Average Precipitation 2W
Wettest Week in 2W
Average Precipitation 12M
Number of dry days in 2W
Average Precipitation 1W
Wettest Week in 4W
Number of dry days in 3M
Number of dry days in 1W
Average Precipitation 24M
Number of dry days in 6M
Average Precipitation 6M
Average Precipitation 3M
Precip Intensity 1W
Days Tmax > 1SD above Tmax 3M
Days Tmax > 90F 12M
Average Precipitation 3D
Precip Intensity 24M
Number of dry days in 12M
Precip Intensity 12M
Days Tmax > 1SD above Tmax 6M
Days Tmax > 90F 3M
PRIMARY PREDICTORS
2-4 week PR + DRY DAYS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Number of dry days in 6M
Average Precipitation 6M
Average Precipitation 3M
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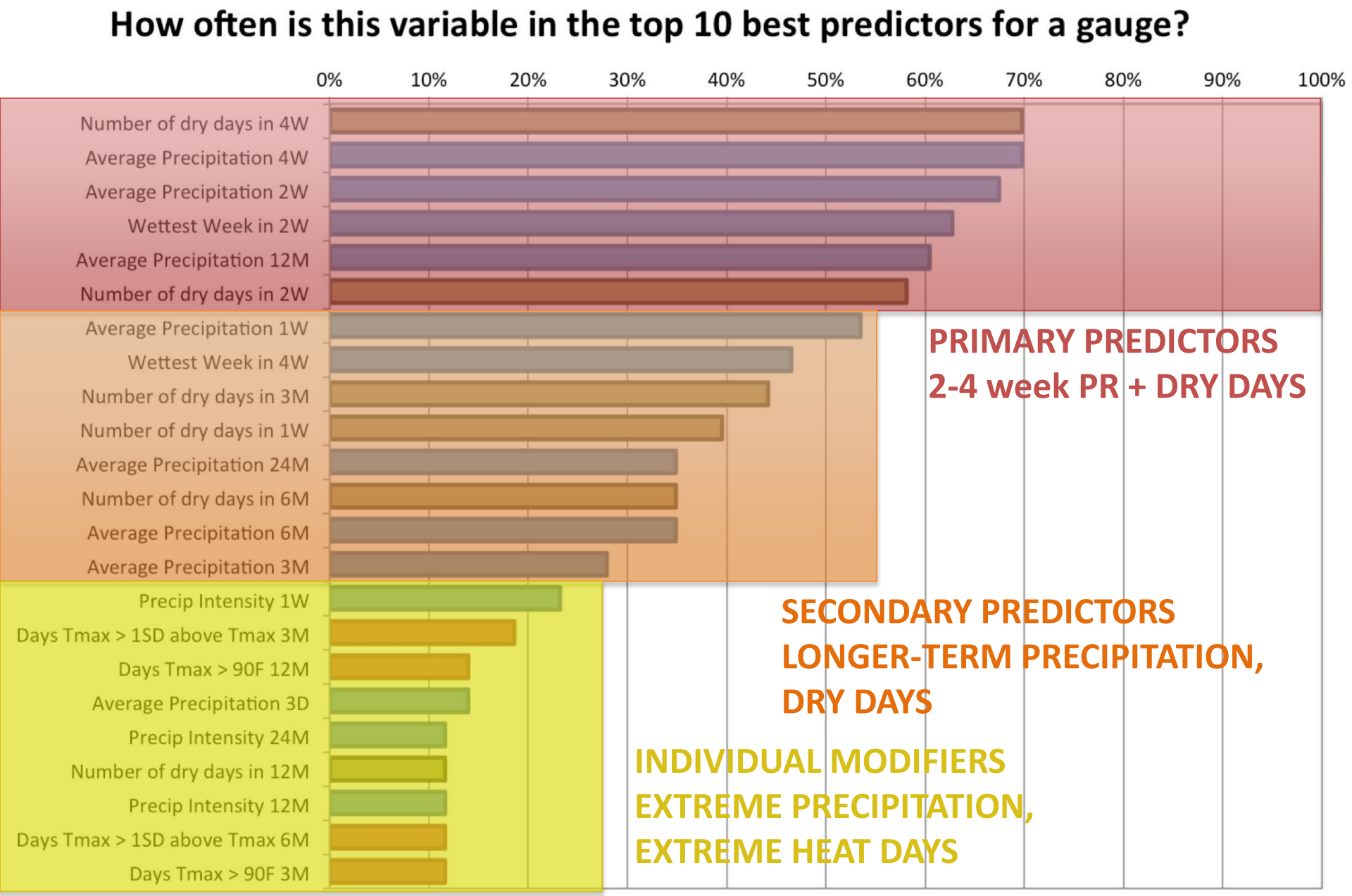
PRIMARY PREDICTORS
2-4 week PR + DRY DAYS
SECONDARY PREDICTORS
LONGER-TERM PRECIPITATION,
DRY DAYS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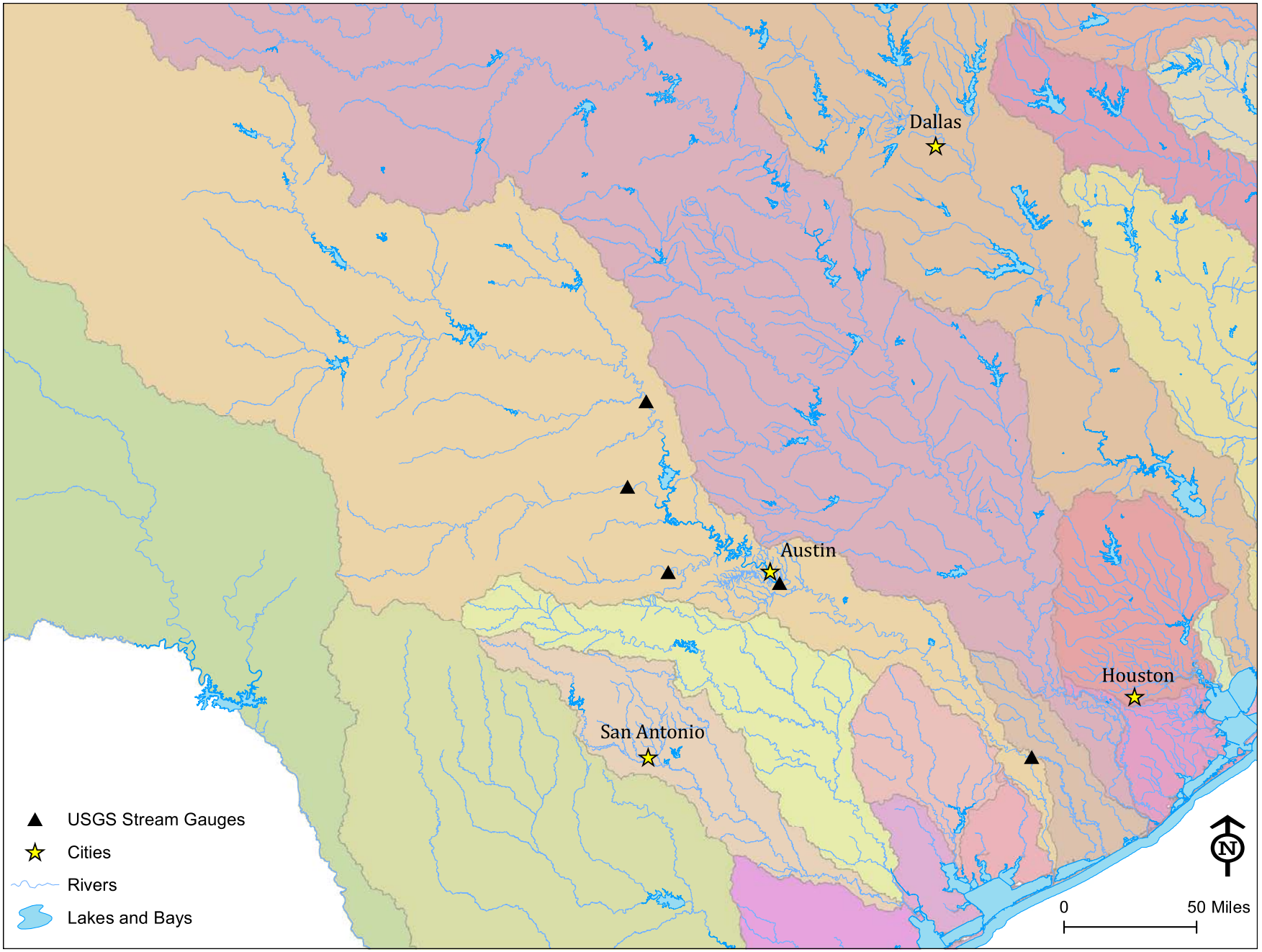
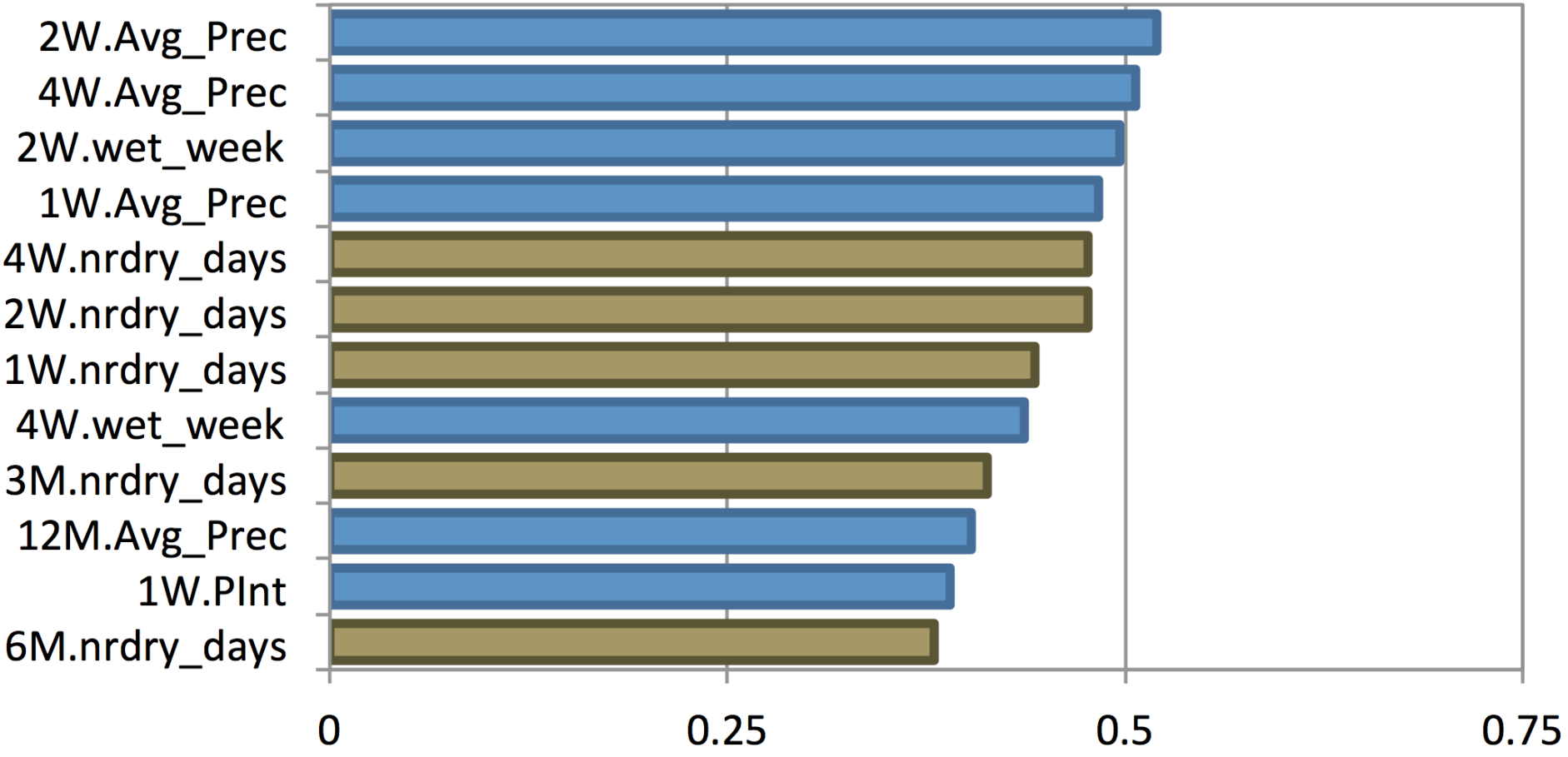
SECONDARY PREDICTORS
LONGER-TERM PRECIPITATION,
DRY DAYS
INDIVIDUAL MODIFIERS
EXTREME PRECIPITATION,
EXTREME HEAT DAYS


Dallas
Austin
Houston
San Antonio
USGS Stream Gauges
Cities
Rivers
Lakes and Bays
N
0
50 Miles

Dallas
COLORADO AT SAN SABA
LLANO AT LLANO
Austin
PEDERNALES AT JOHNSON CITY
COLORADO AT AUSTIN
Houston
San Antonio
COLORADO AT WHARTON
USGS Stream Gauges
Cities
Rivers
Lakes and Bays
N
0
50 Miles

TOP STREAMFLOW PREDICTORS

Colorado River at San Saba



TOP STREAMFLOW PREDICTORS

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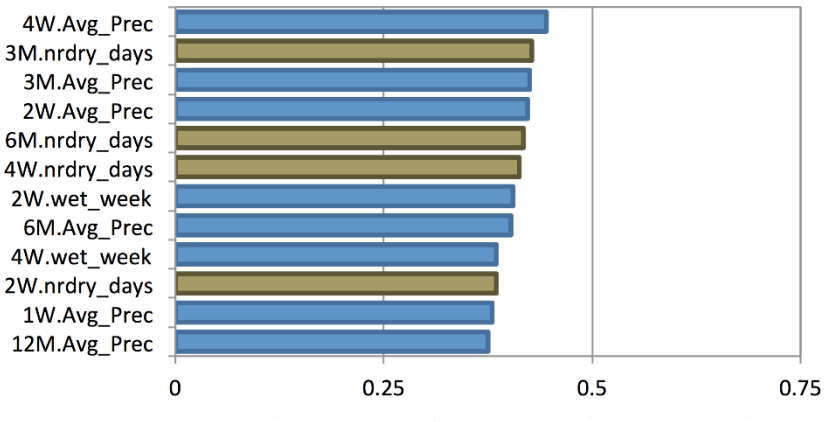
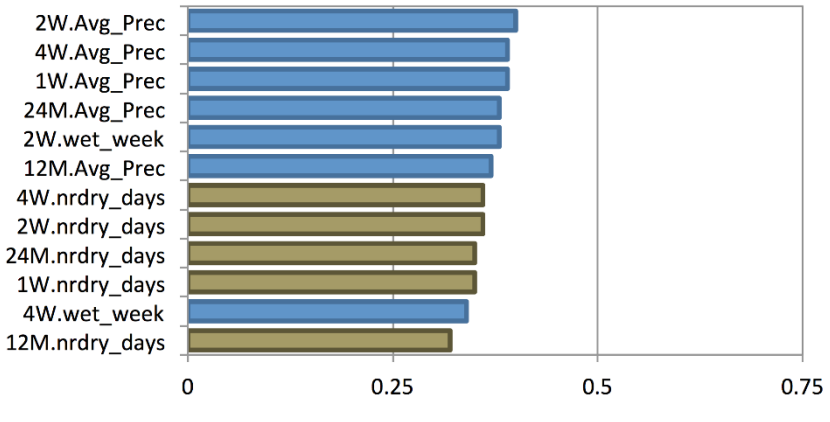


Pedernales at Johnson City



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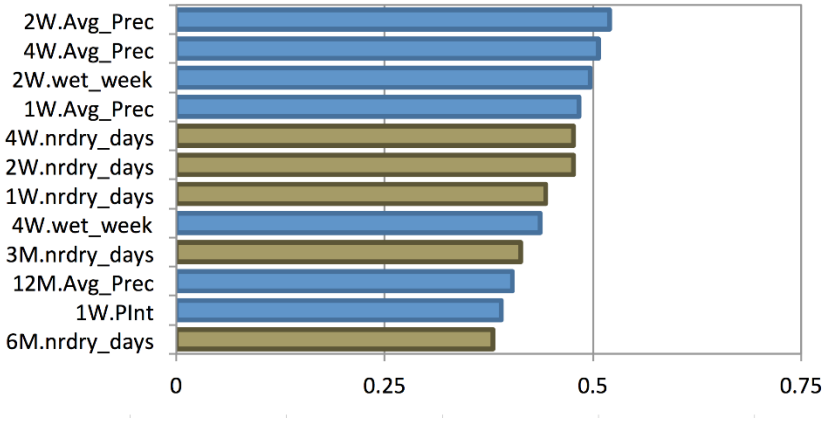
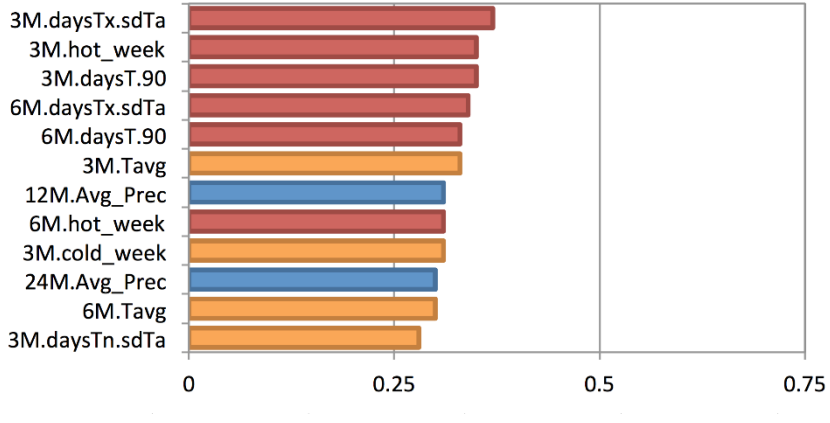
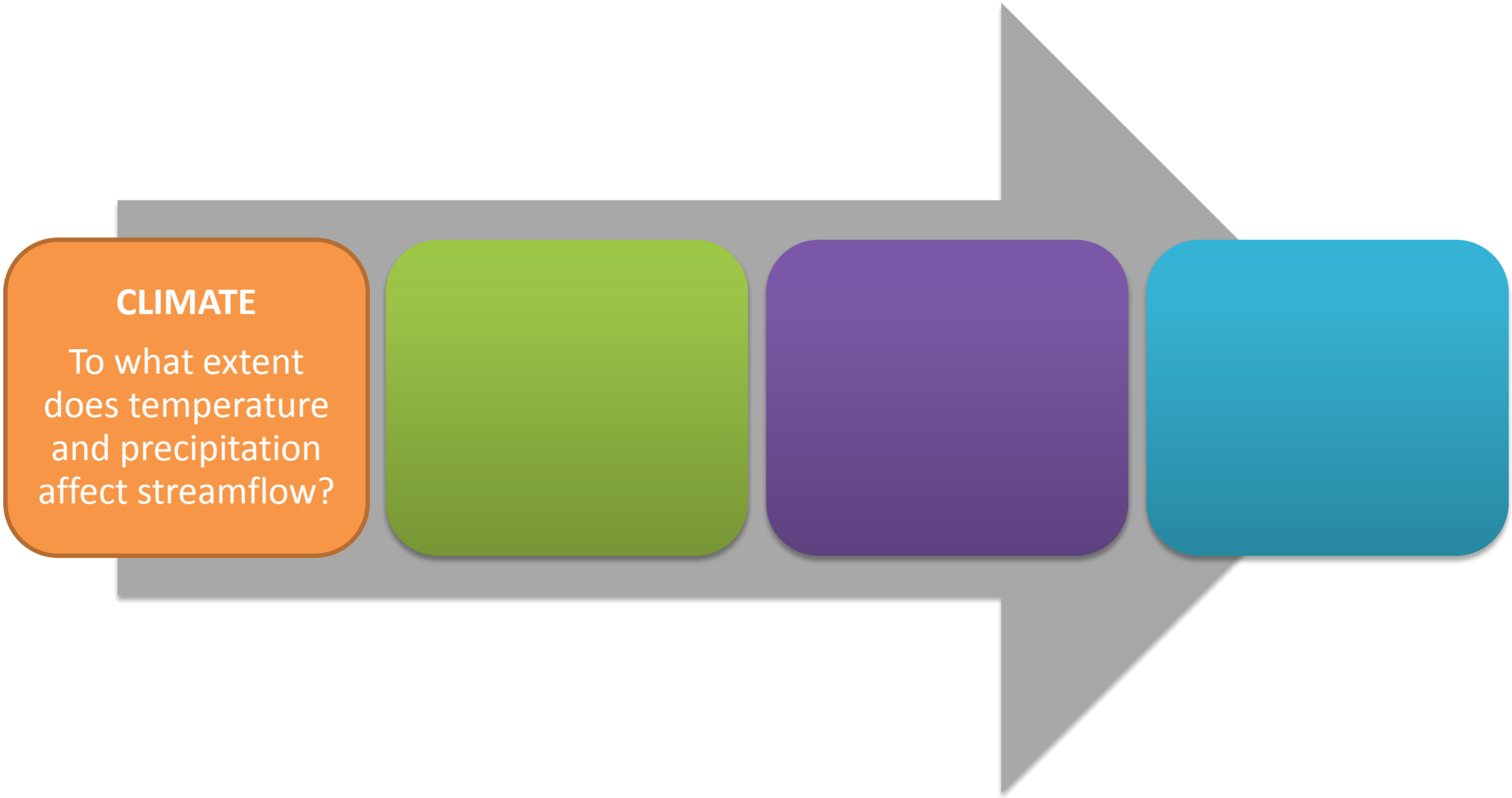
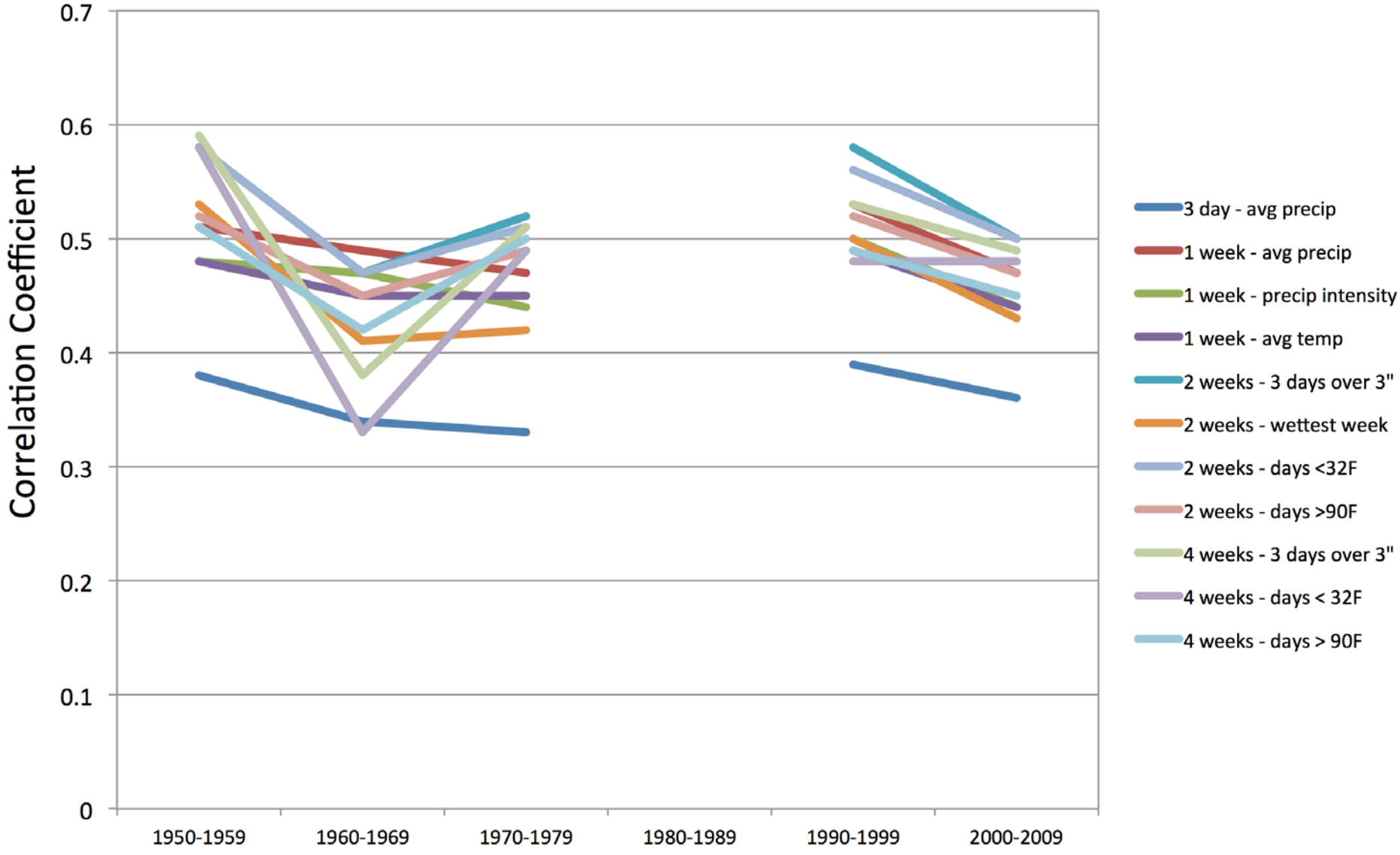


Llano River at Llano

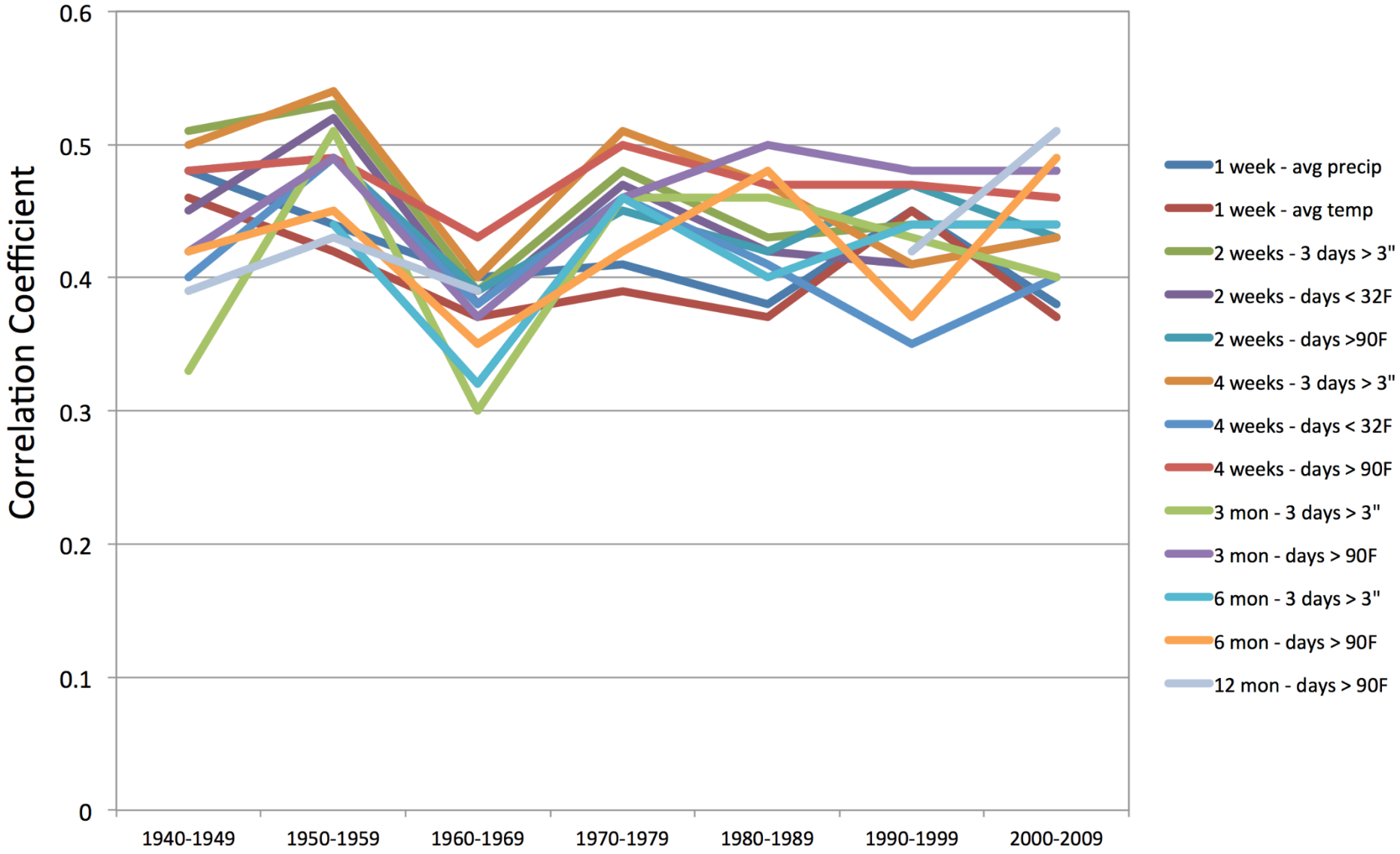



CLIMATE
To what extent does temperature and precipitation affect streamflow?

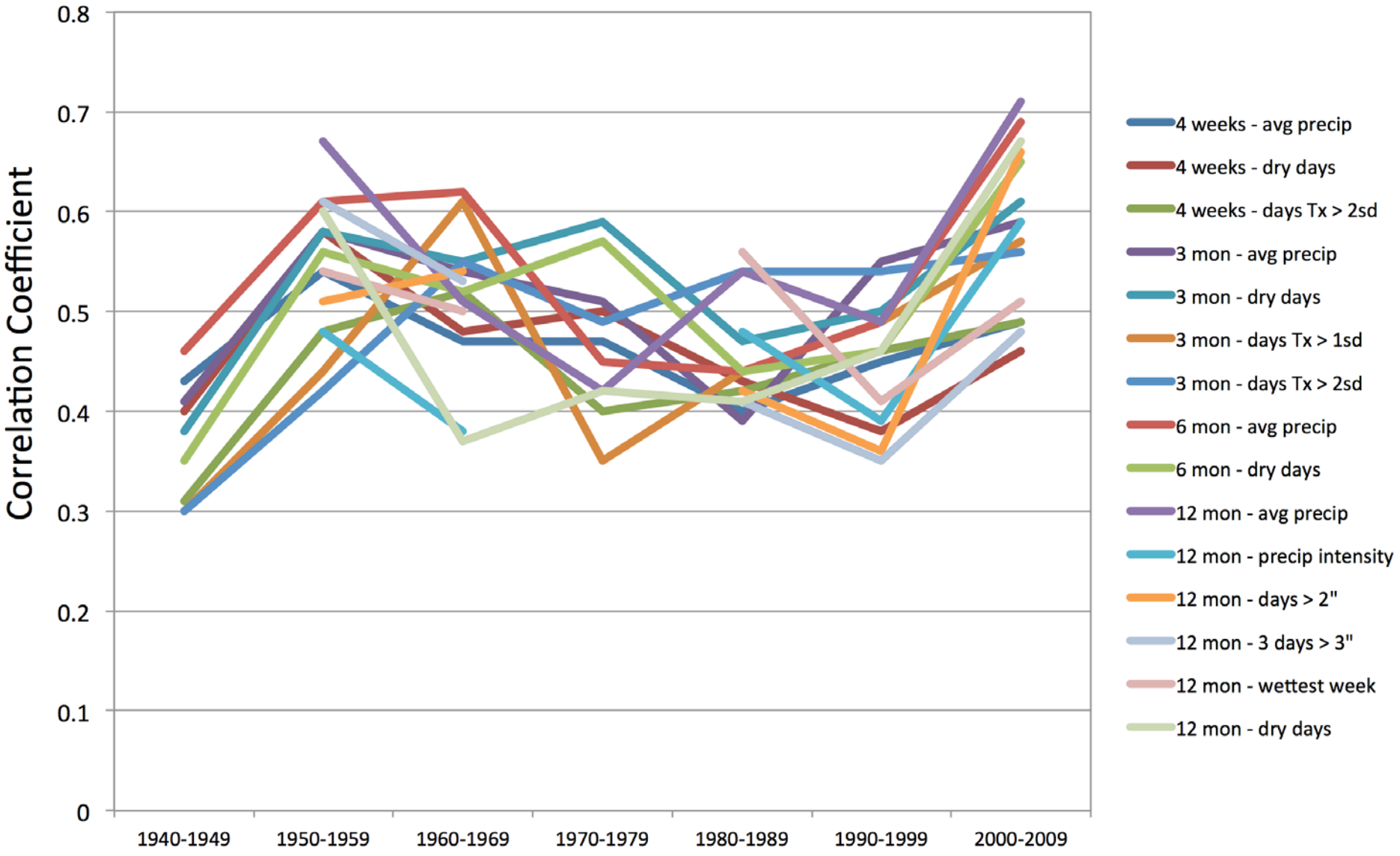
Colorado River at San Saba



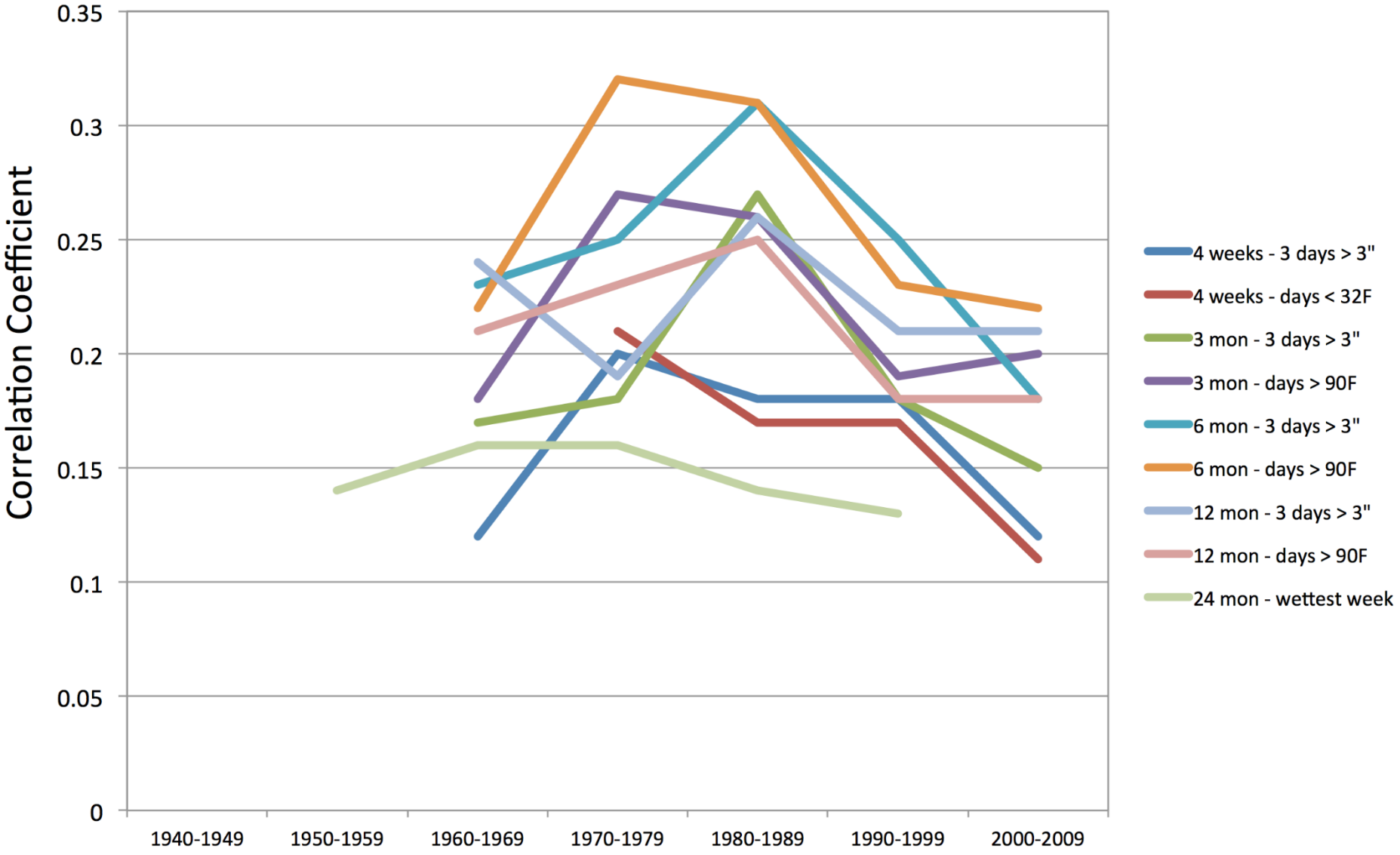
Colorado River at Austin

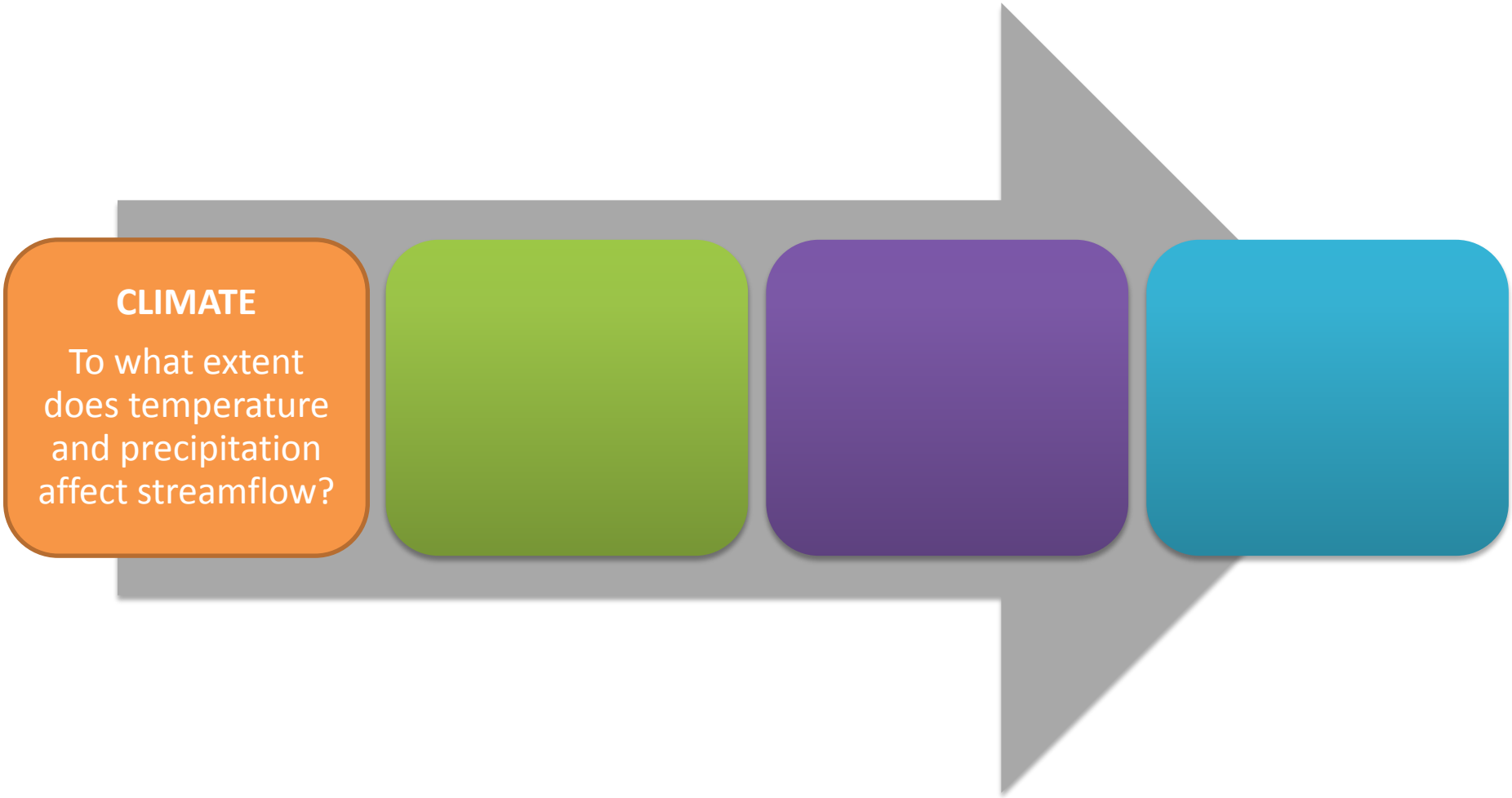


Pedernales River at Johnson City



Colorado River at Wharton

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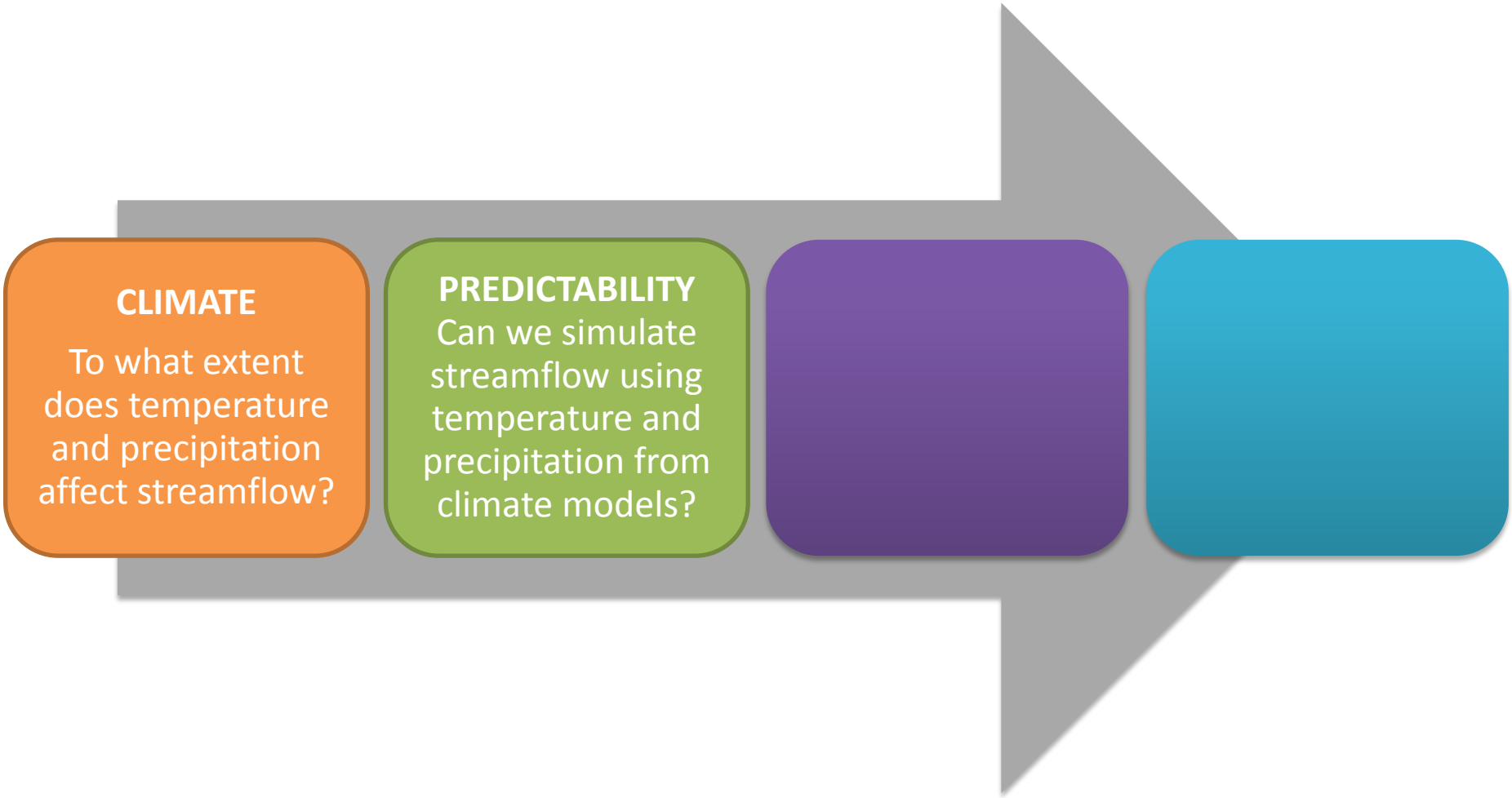
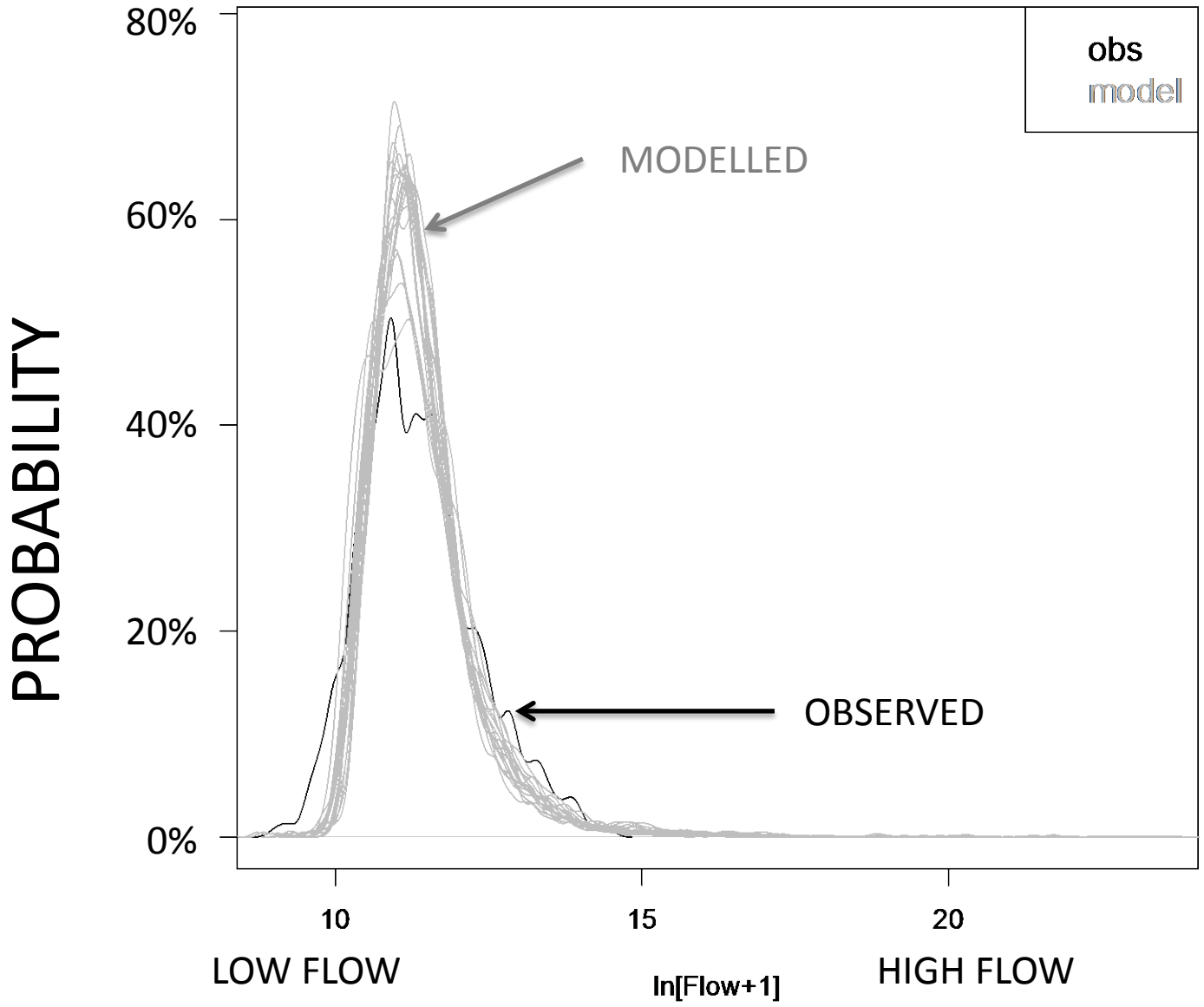
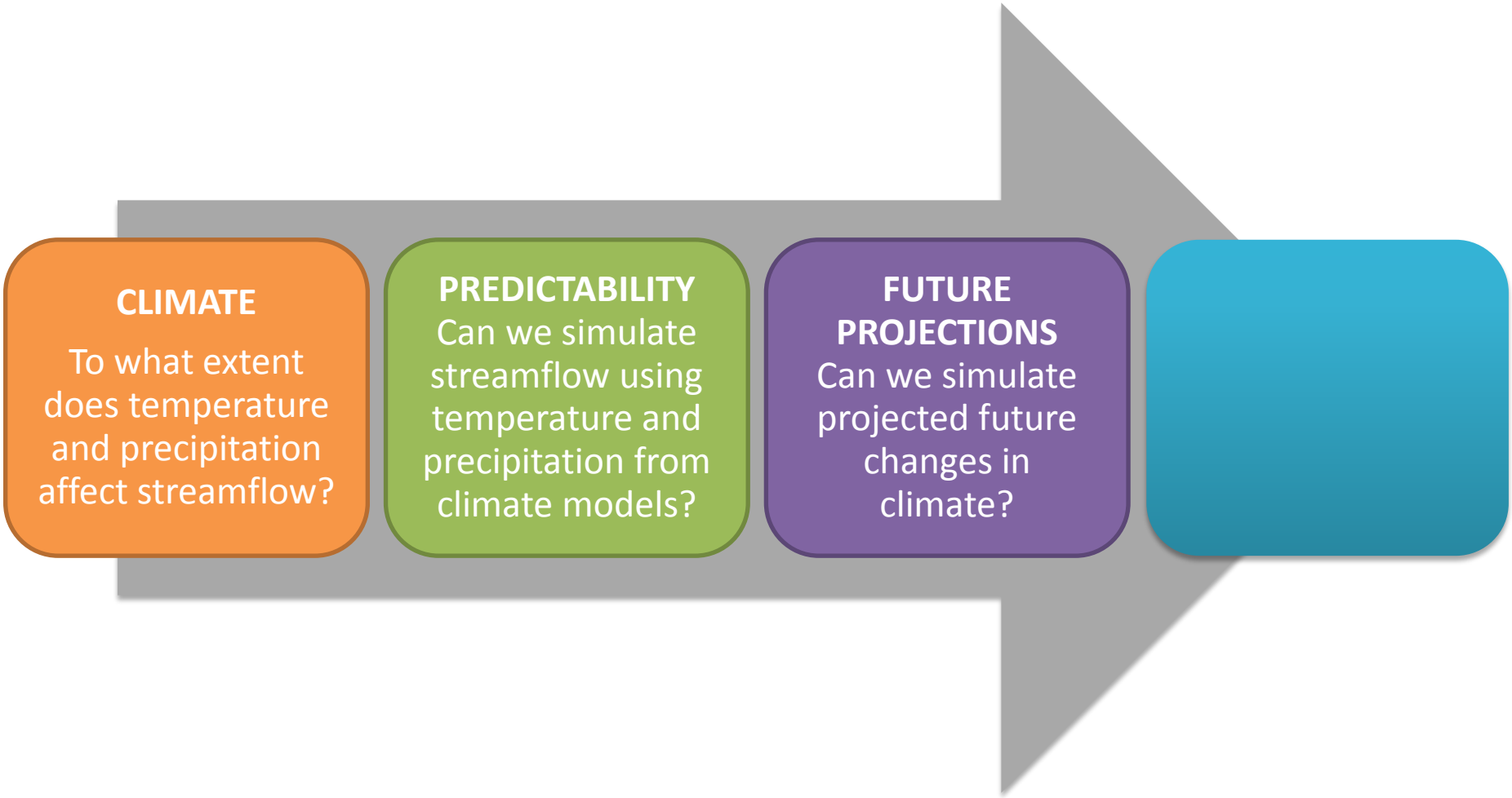
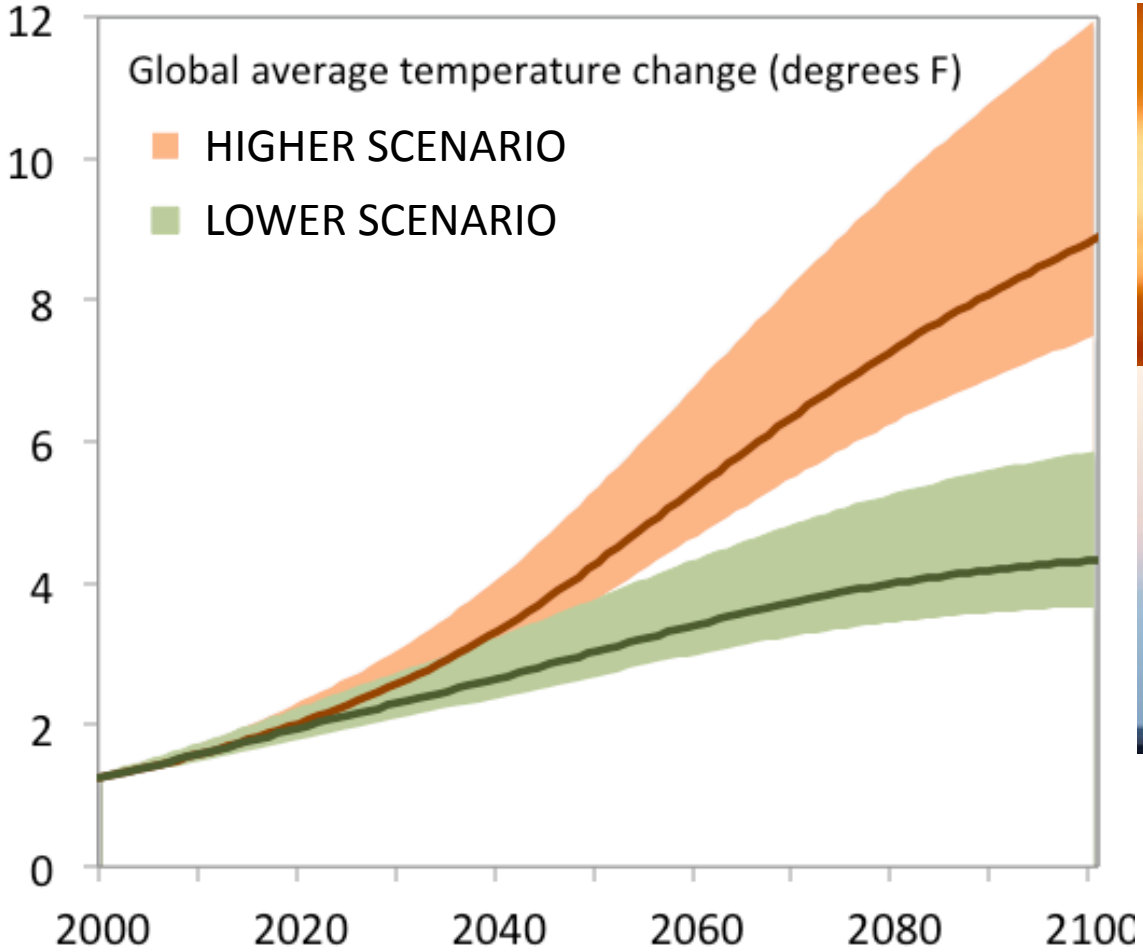

CLIMATE
To what extent does temperature and precipitation affect streamflow?
PREDICTABILITY
Can we simulate streamflow using temperature and precipitation from climate models?

Colorado River at Austin

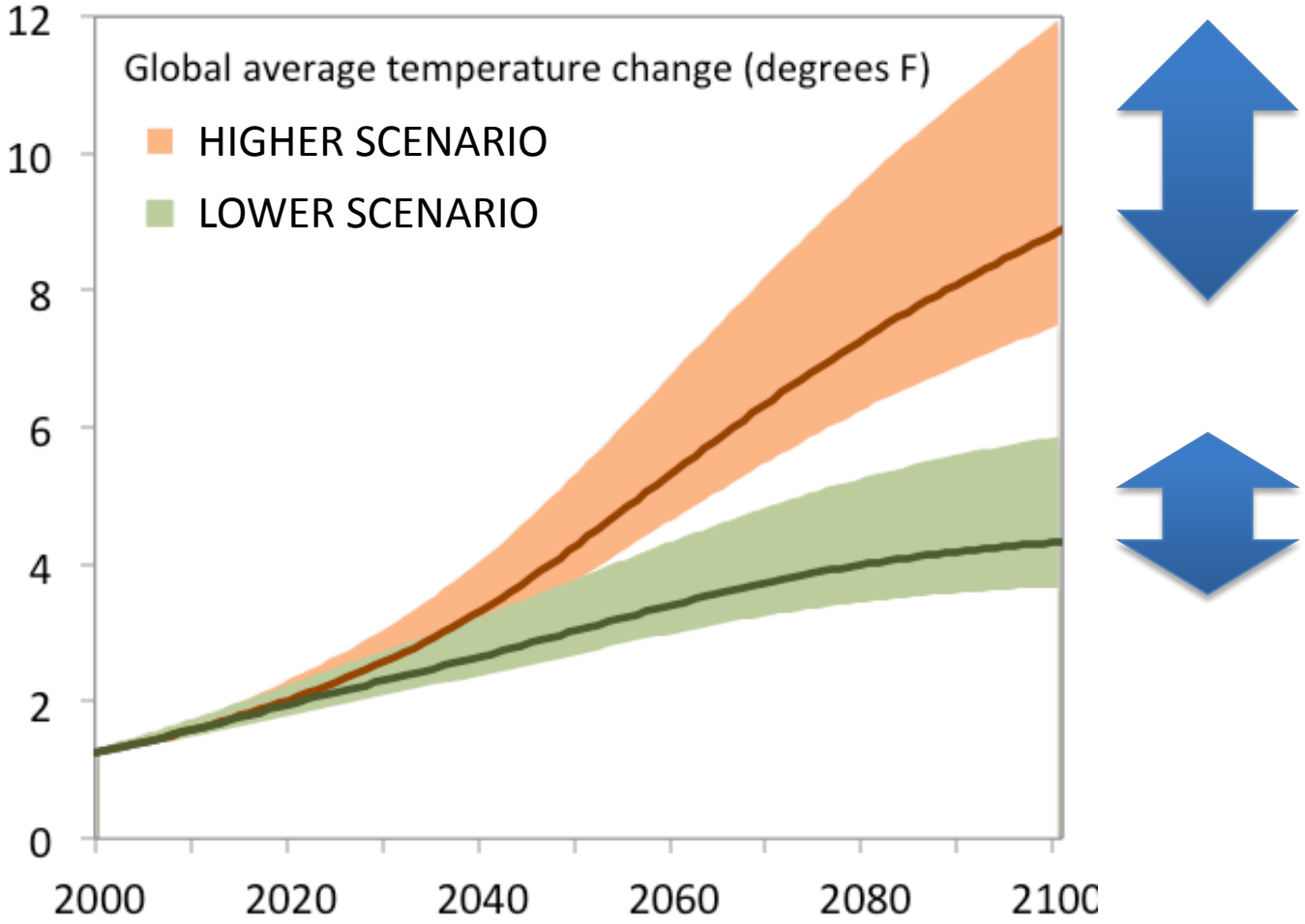



CLIMATE
To what extent does temperature and precipitation affect streamflow?
PREDICTABILITY
Can we simulate streamflow using temperature and precipitation from climate models?
FUTURE PROJECTIONS
Can we simulate projected future changes in climate?

FUTURE CHANGE DEPENDS ON OUR CHOICES

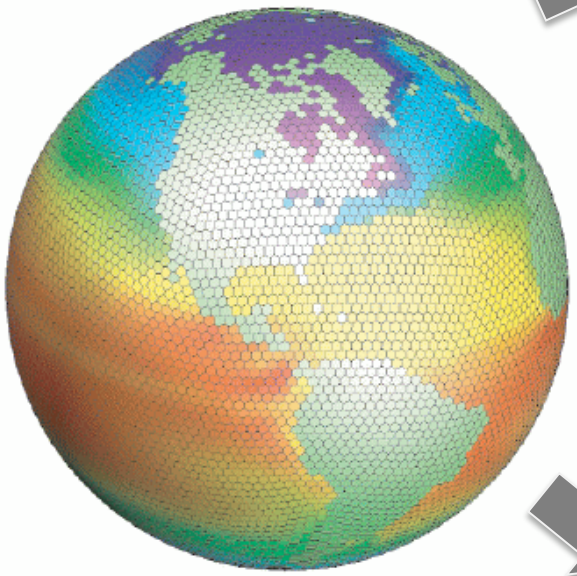


FUTURE CHANGE DEPENDS ON HOW SENSITIVE THE PLANET IS

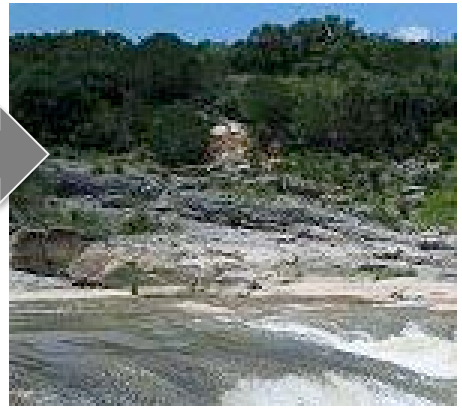


GAUGE-SPECIFIC FUTURE PROJECTIONS

2 FUTURE SCENARIOS

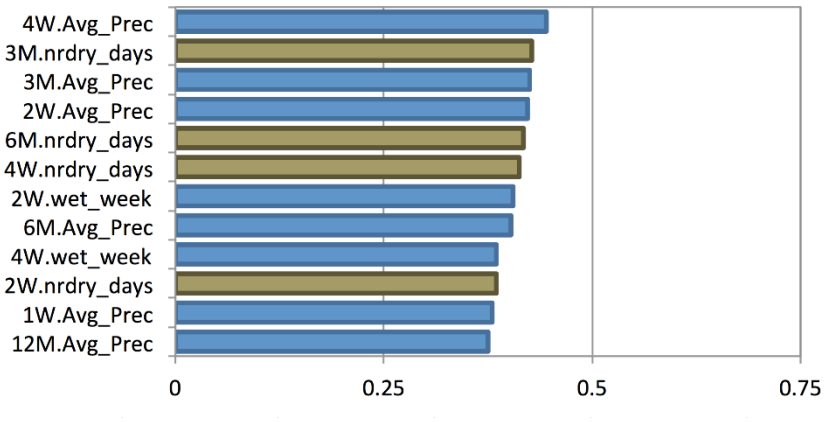


20 GLOBAL CLIMATE MODELS

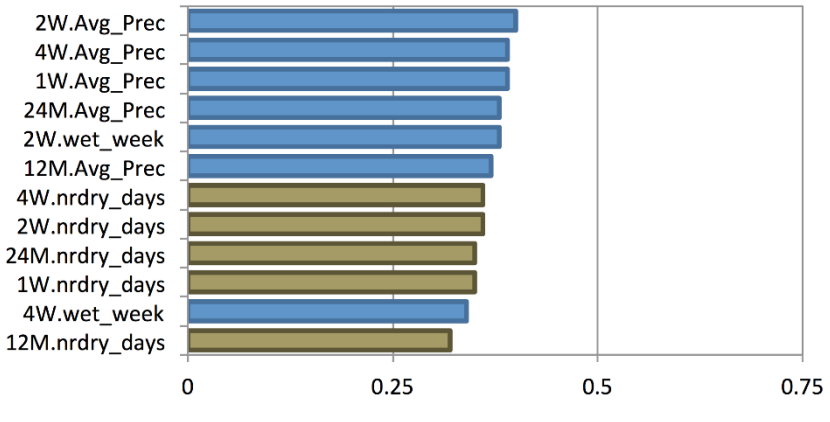


TOP STREAMFLOW PREDICTORS

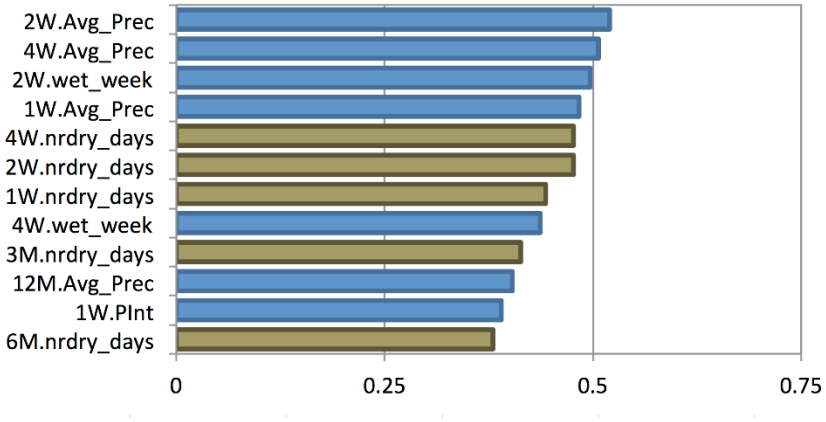
Colorado River at Austin



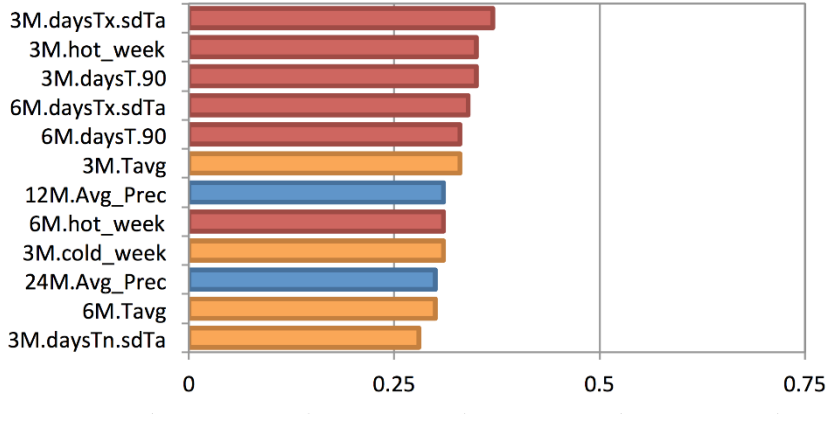
Pedernales at Johnson City



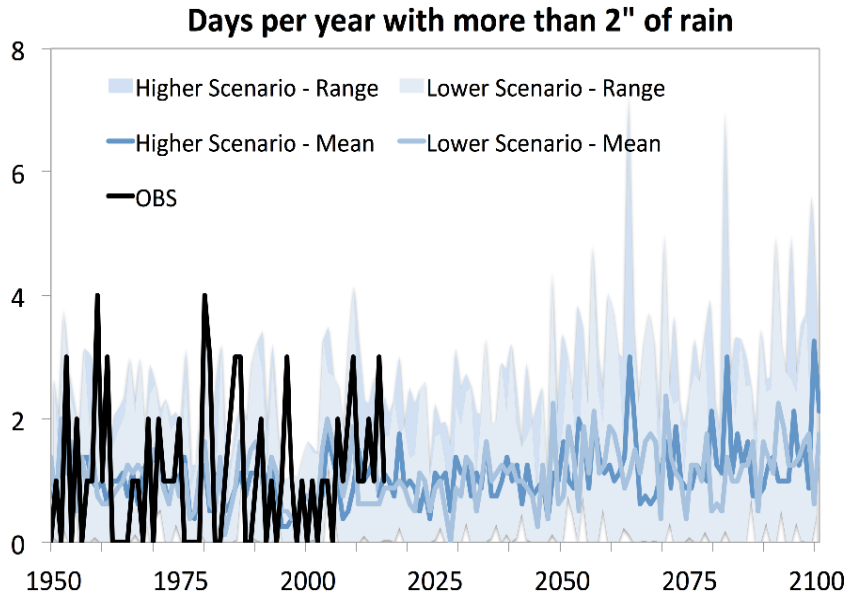
Colorado River at San Saba

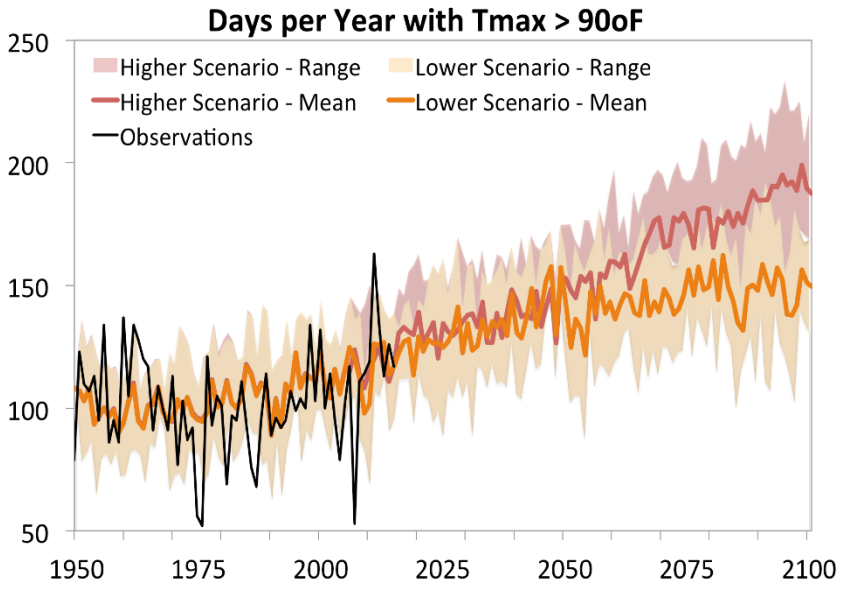


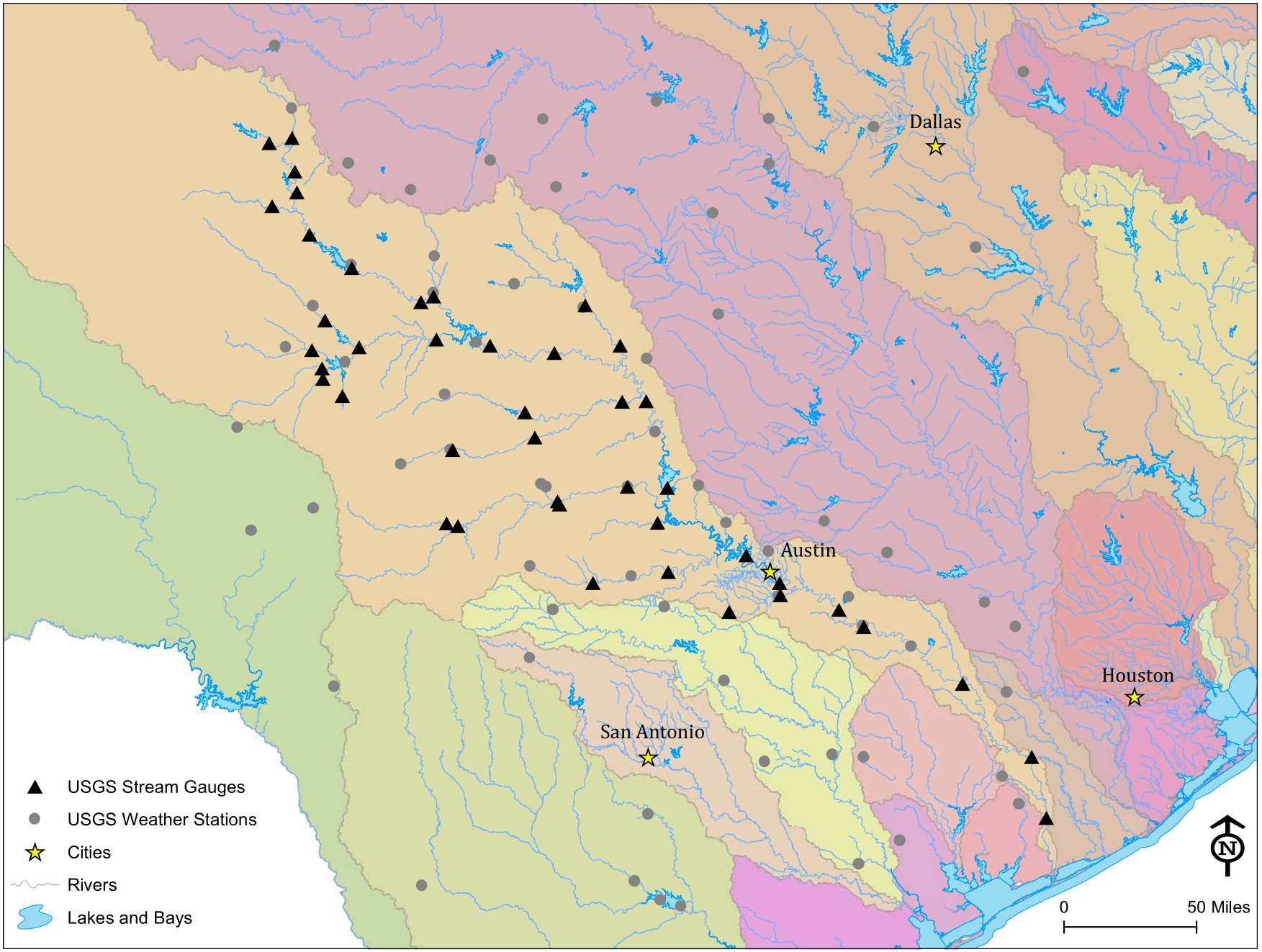
Llano River at Llano



HISTORICAL OBSERVATIONS AND FUTURE PROJECTIONS



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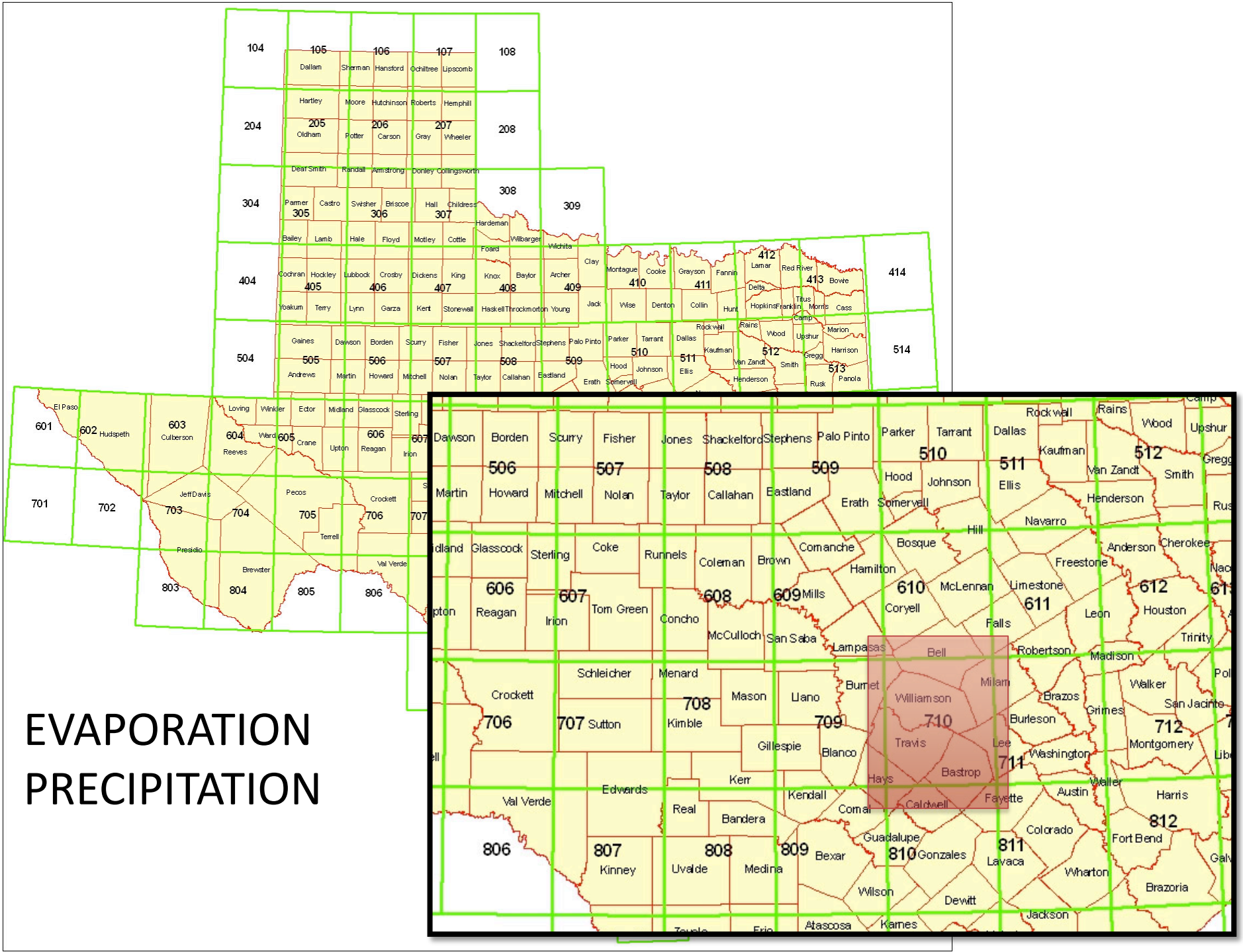
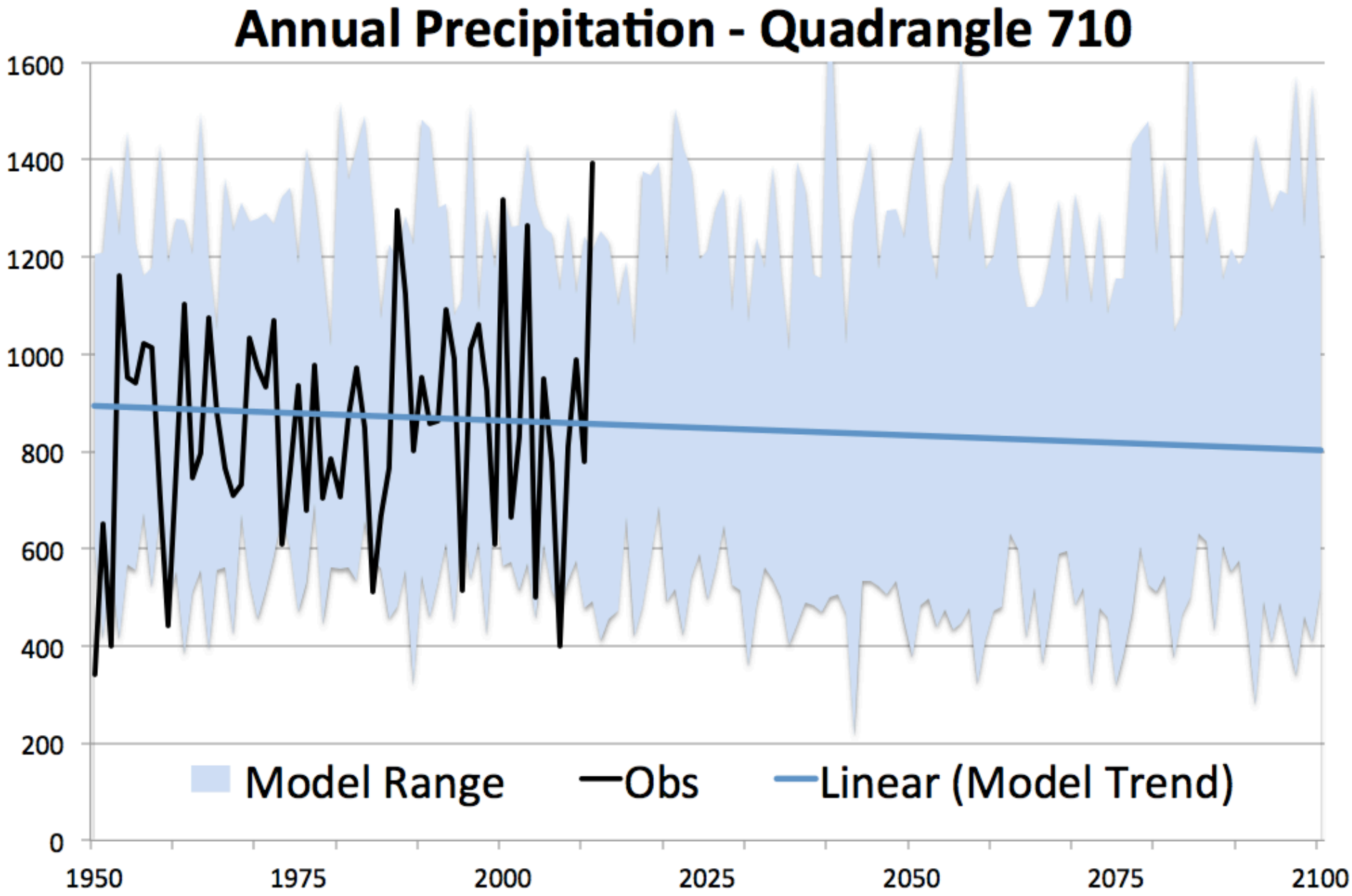
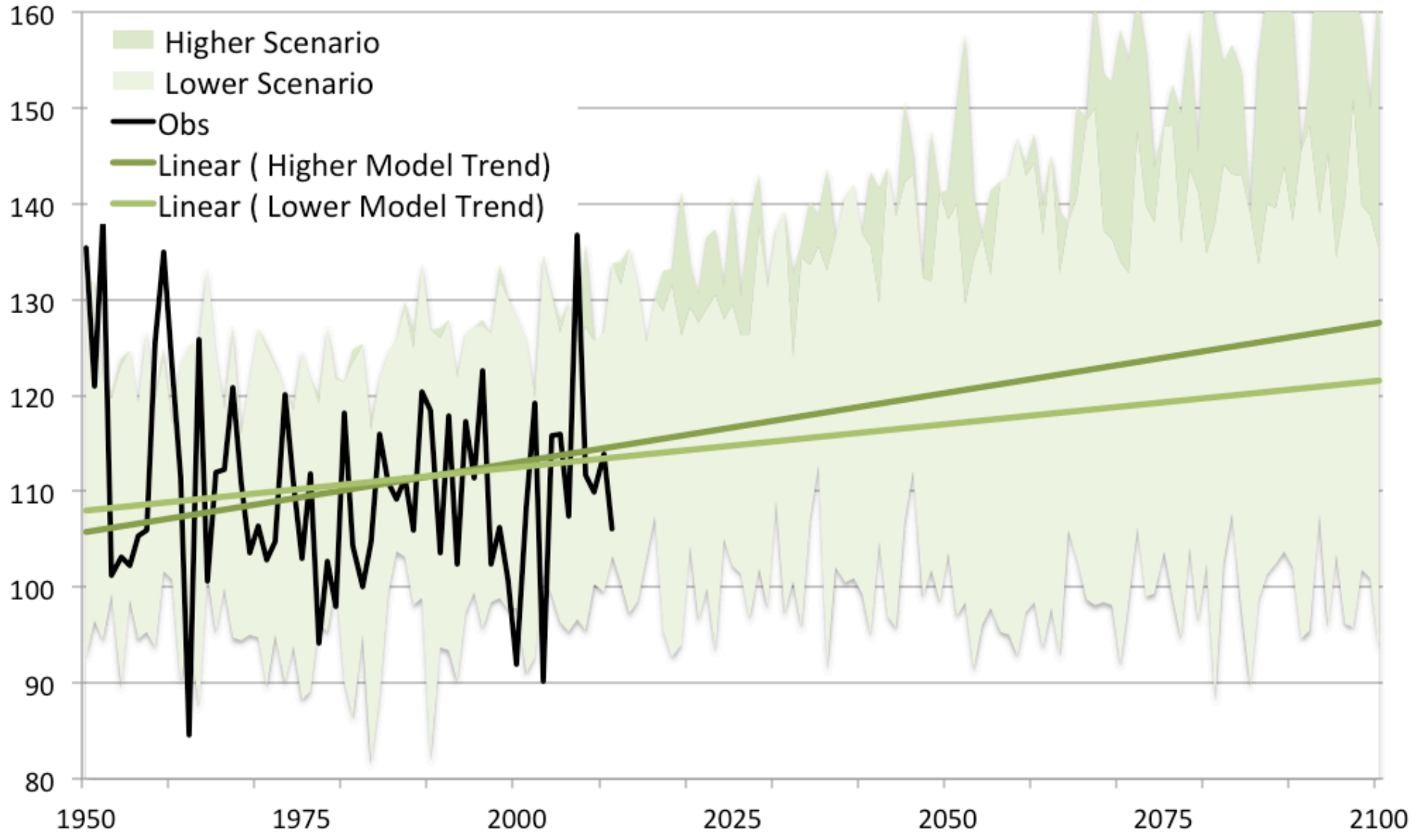
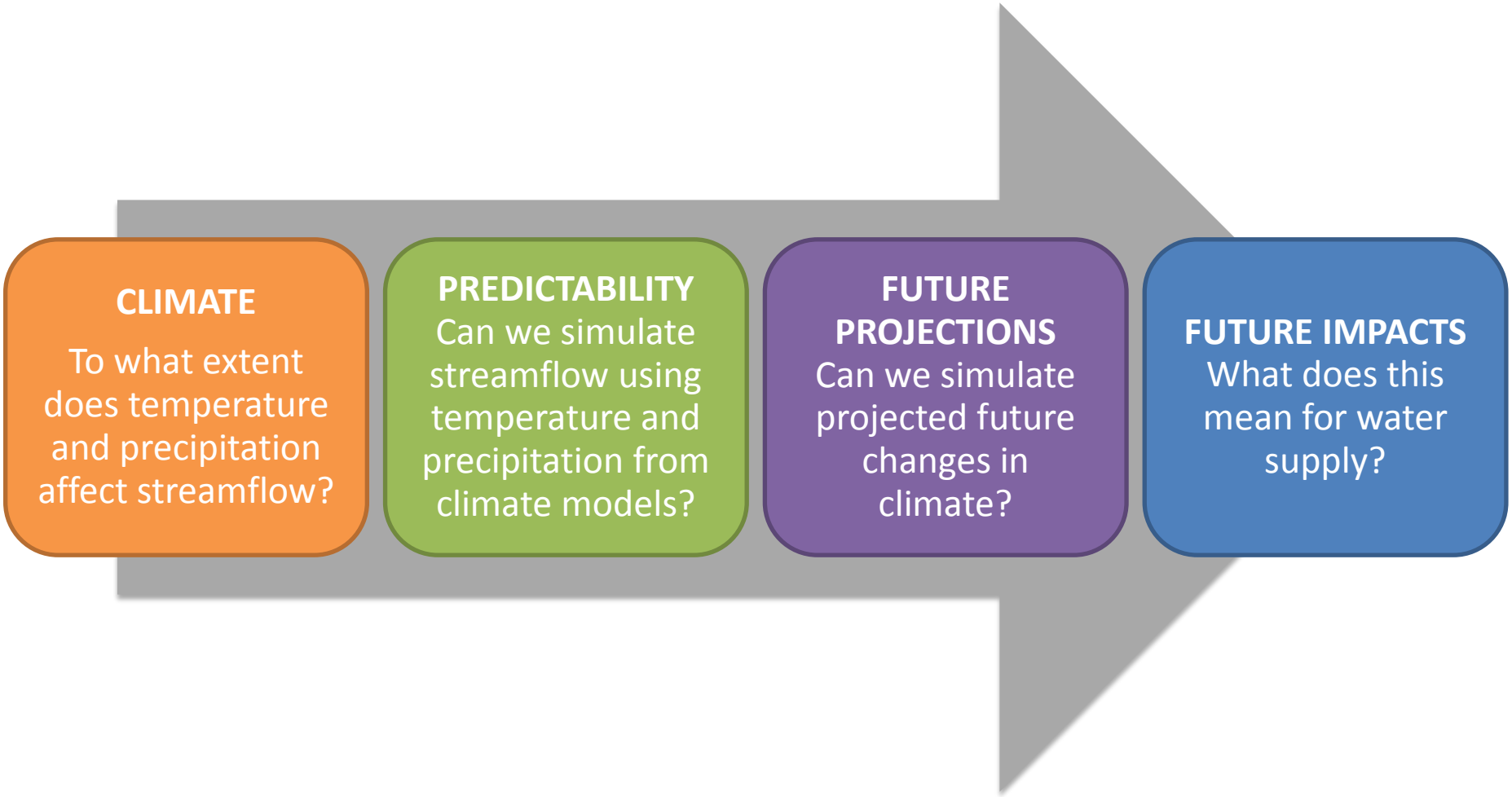
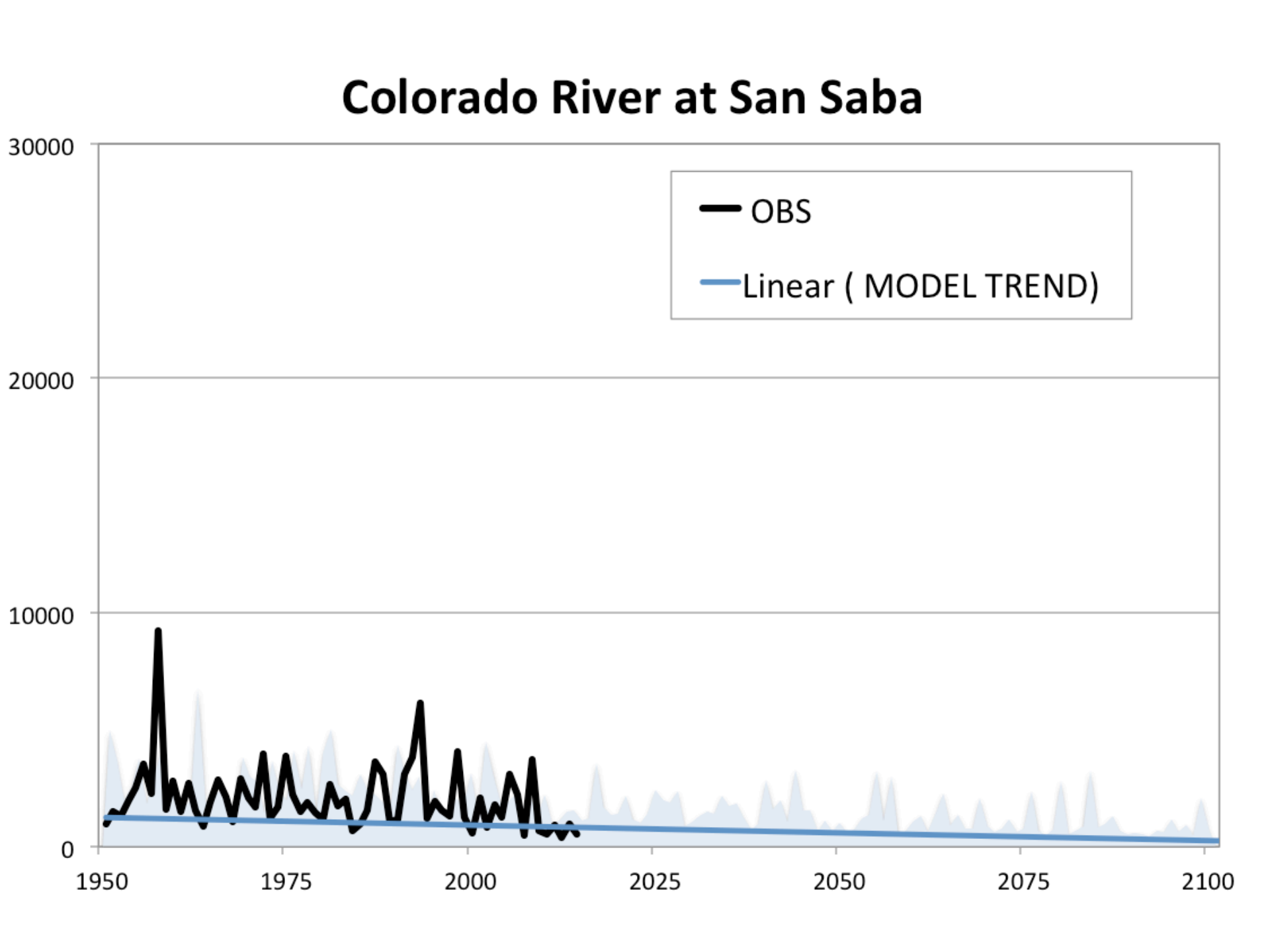

EVAPORATION
PRECIPITATION


Annual Precipitation - Quadrangle 710
1600
1400
1200
1000
800
600
400
200
0
1950
1975
2000
2025
2050
2075
2100
Model Range
Obs
Linear (Model Trend)

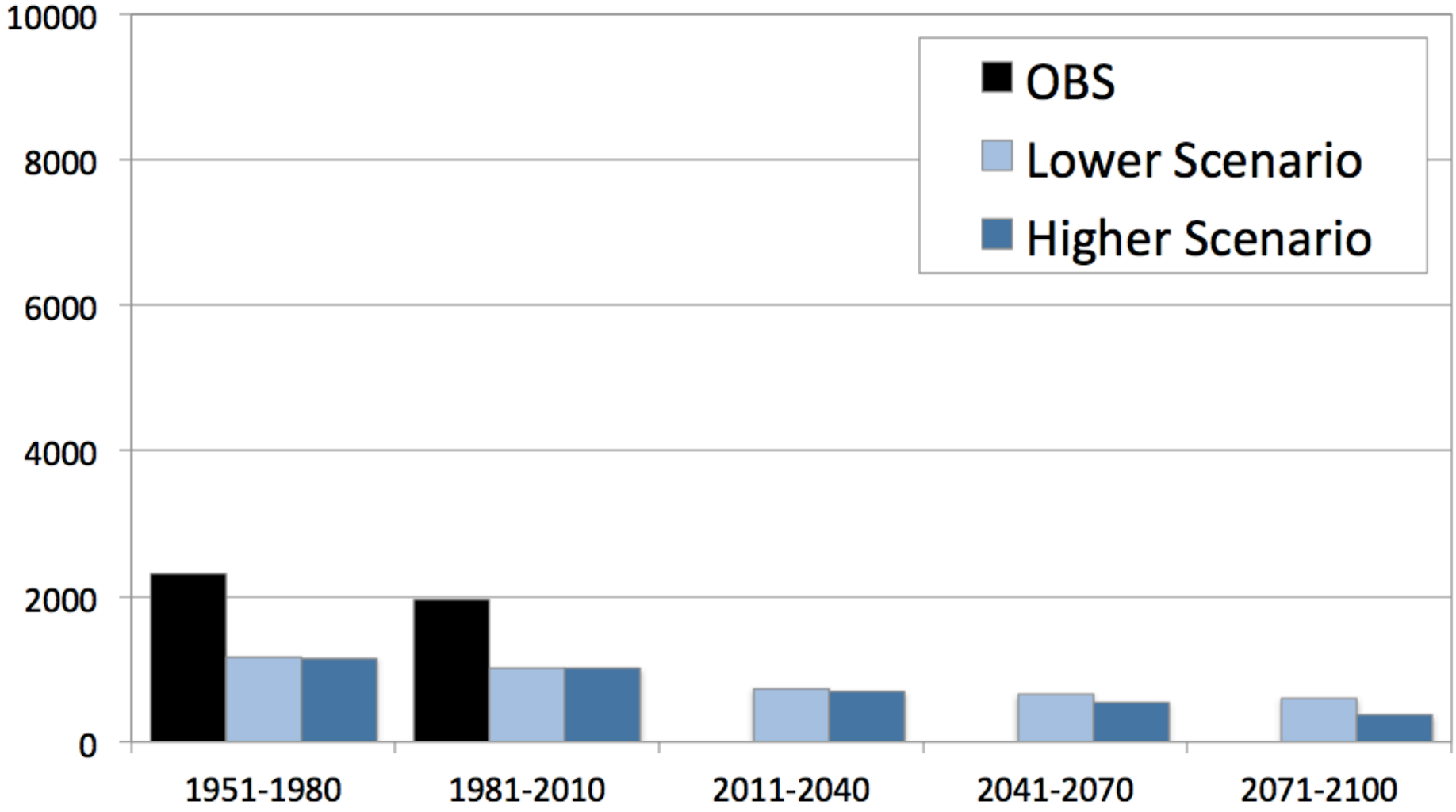
Annual Evaporation - Quadrangle 710



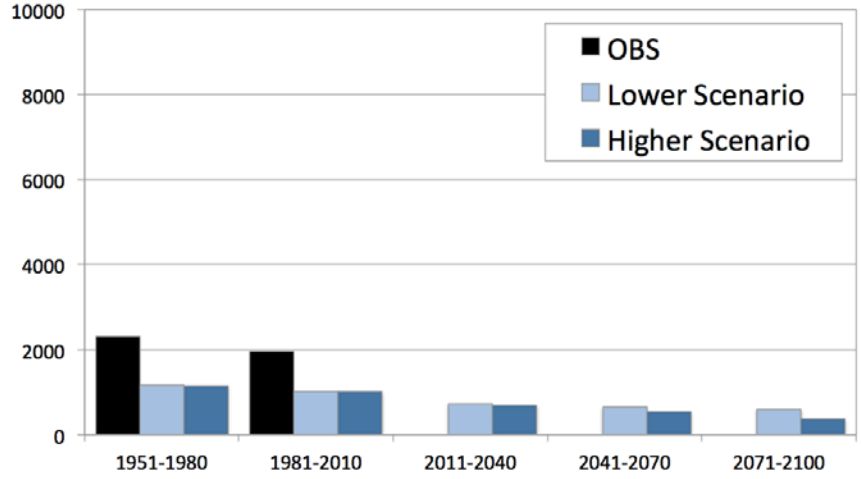

CLIMATE
To what extent does temperature and precipitation affect streamflow?
PREDICTABILITY
Can we simulate streamflow using temperature and precipitation from climate models?
FUTURE PROJECTIONS
Can we simulate projected future changes in climate?
FUTURE IMPACTS
What does this mean for water supply?


Colorado River at San Saba
30000
20000
10000
0
1950
1975
2000
2025
2050
2075
2100
OBS
Linear (MODEL TREND)

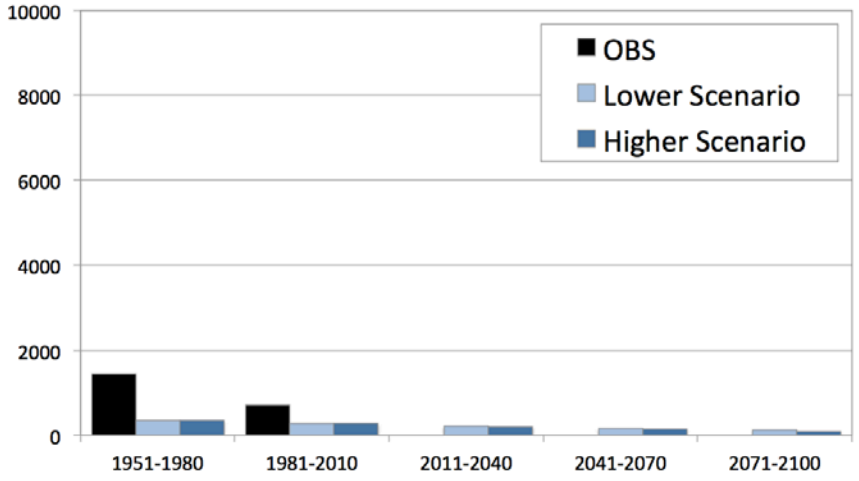
Annual Streamflow
Colorado River at San Saba



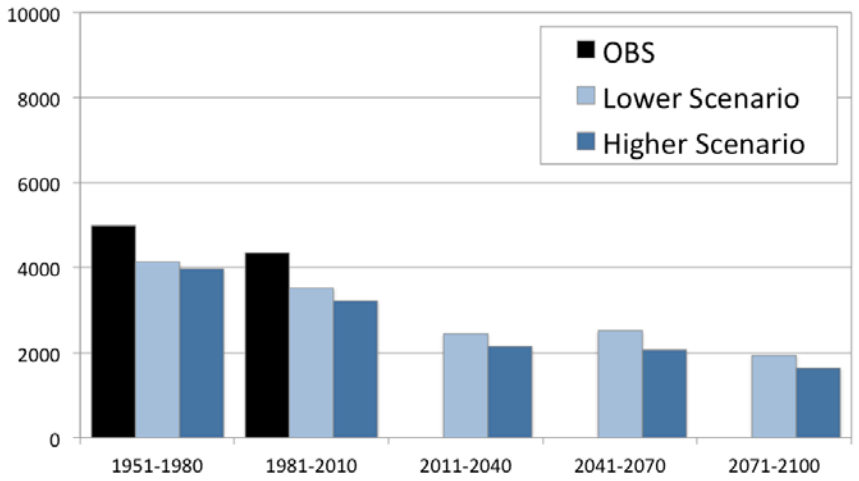
Annual Streamflow
Colorado River at San Saba

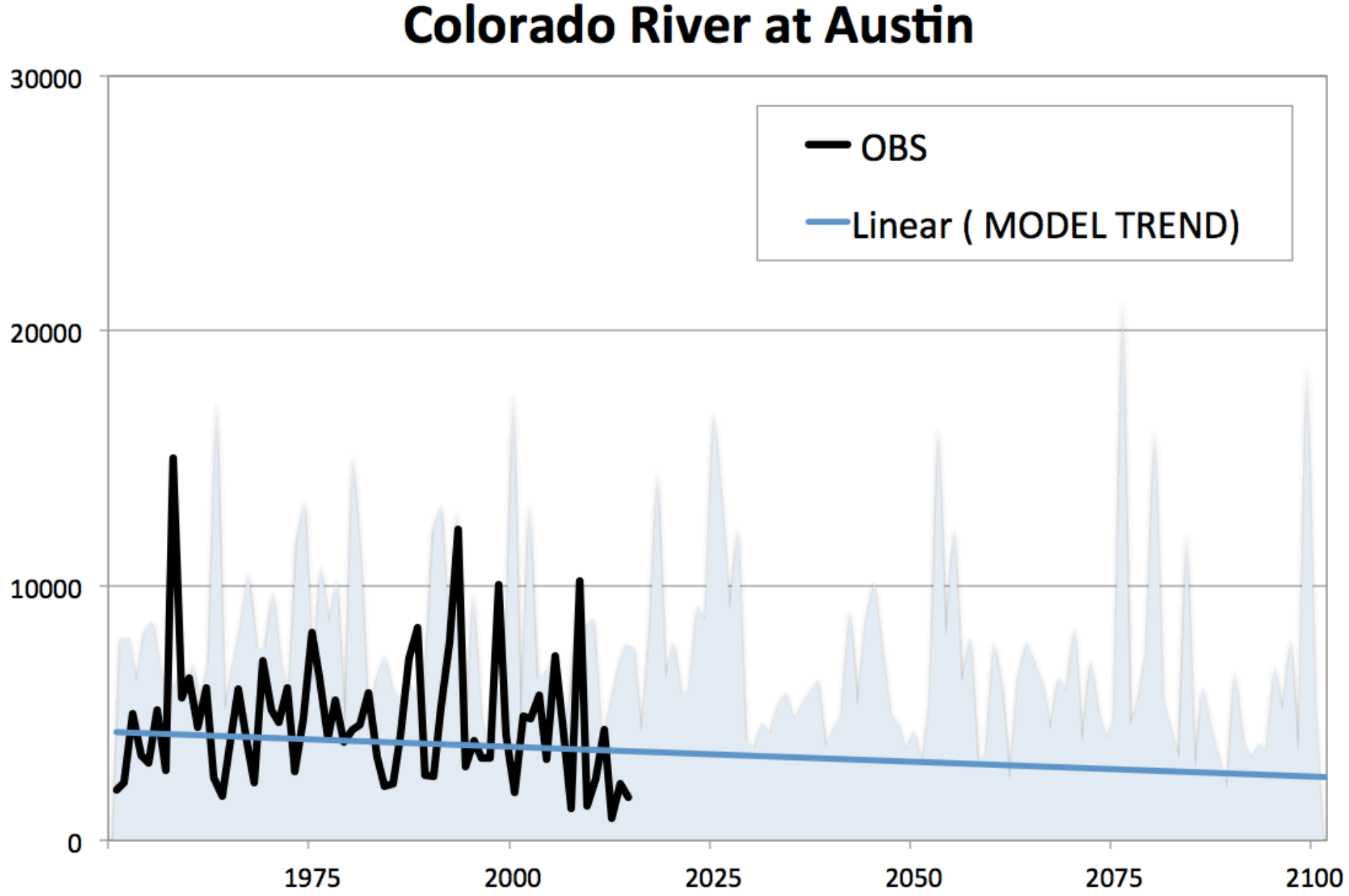


Lowest 3 Years of Streamflow
Colorado River at San Saba

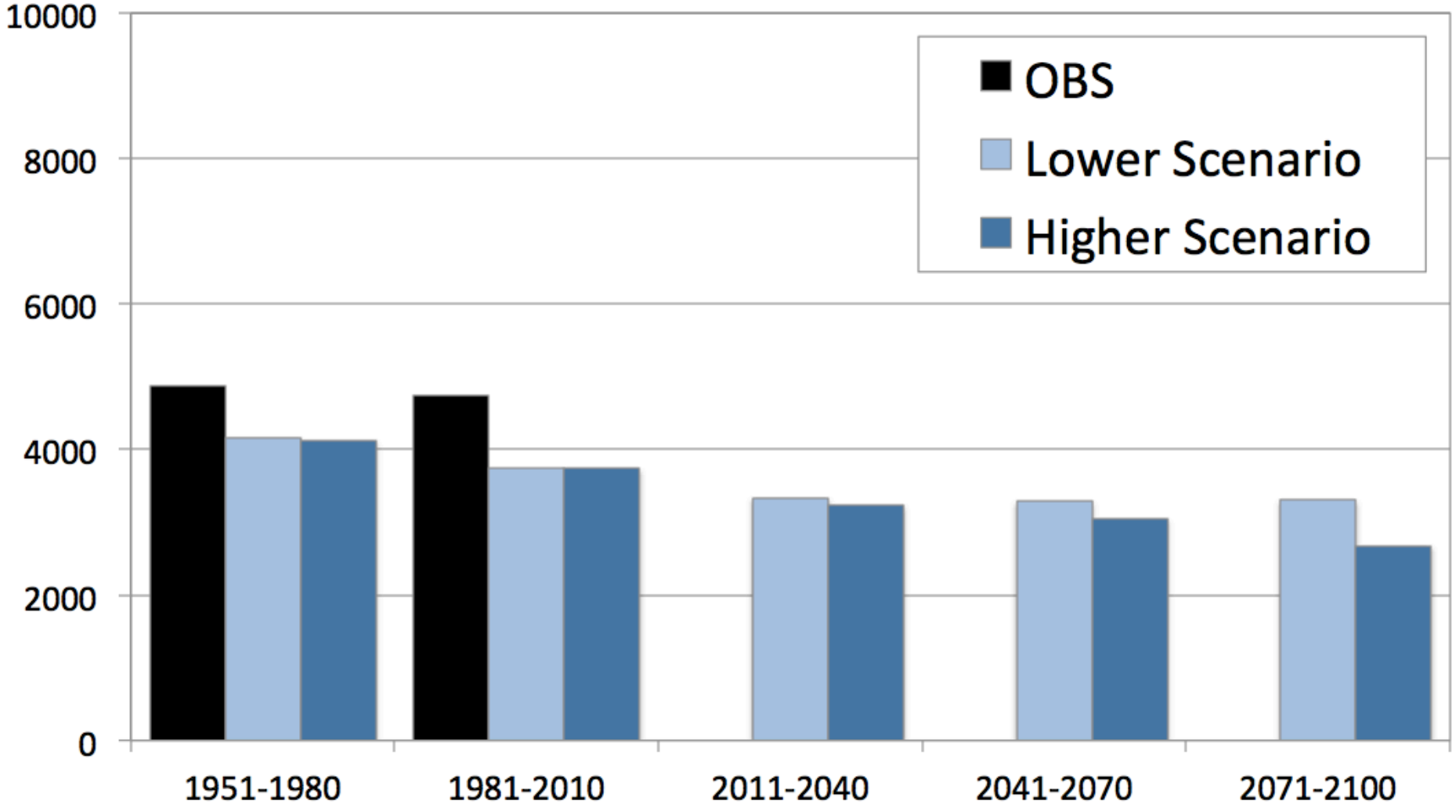


Highest 3 Years of Streamflow
Colorado River at San Saba

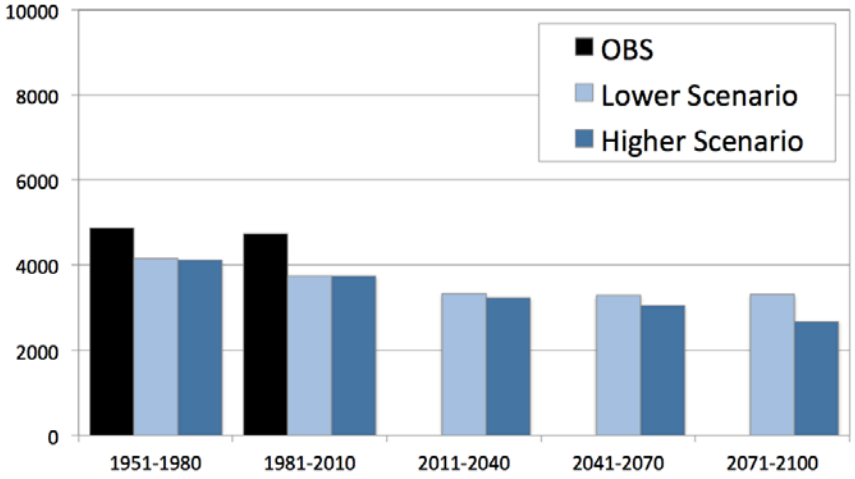



Colorado River at Austin
30000
20000
10000
0
1975
2000
2025
2050
2075
2100
OBS
Linear (MODEL TREND)

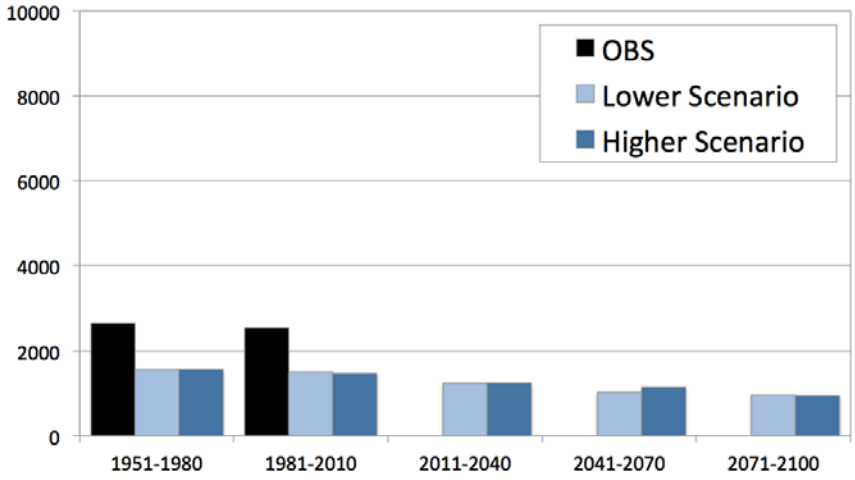
Annual Streamflow
Colorado River at Austin



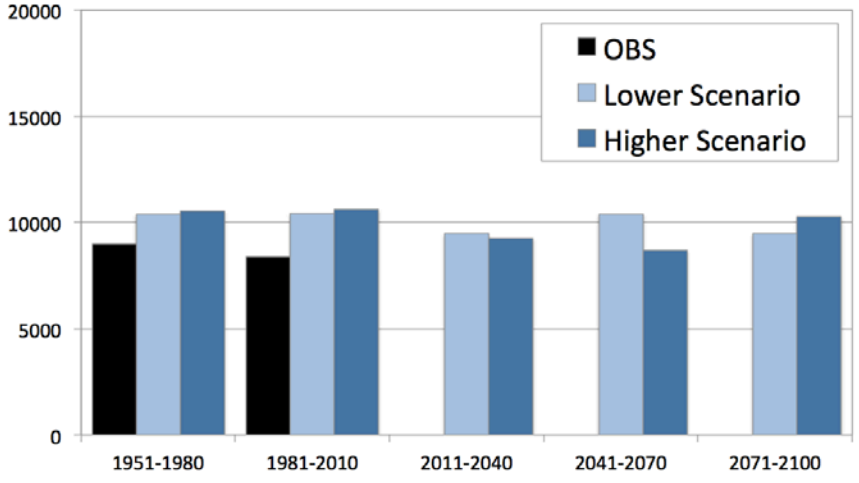
Annual Streamflow
Colorado River at Austin

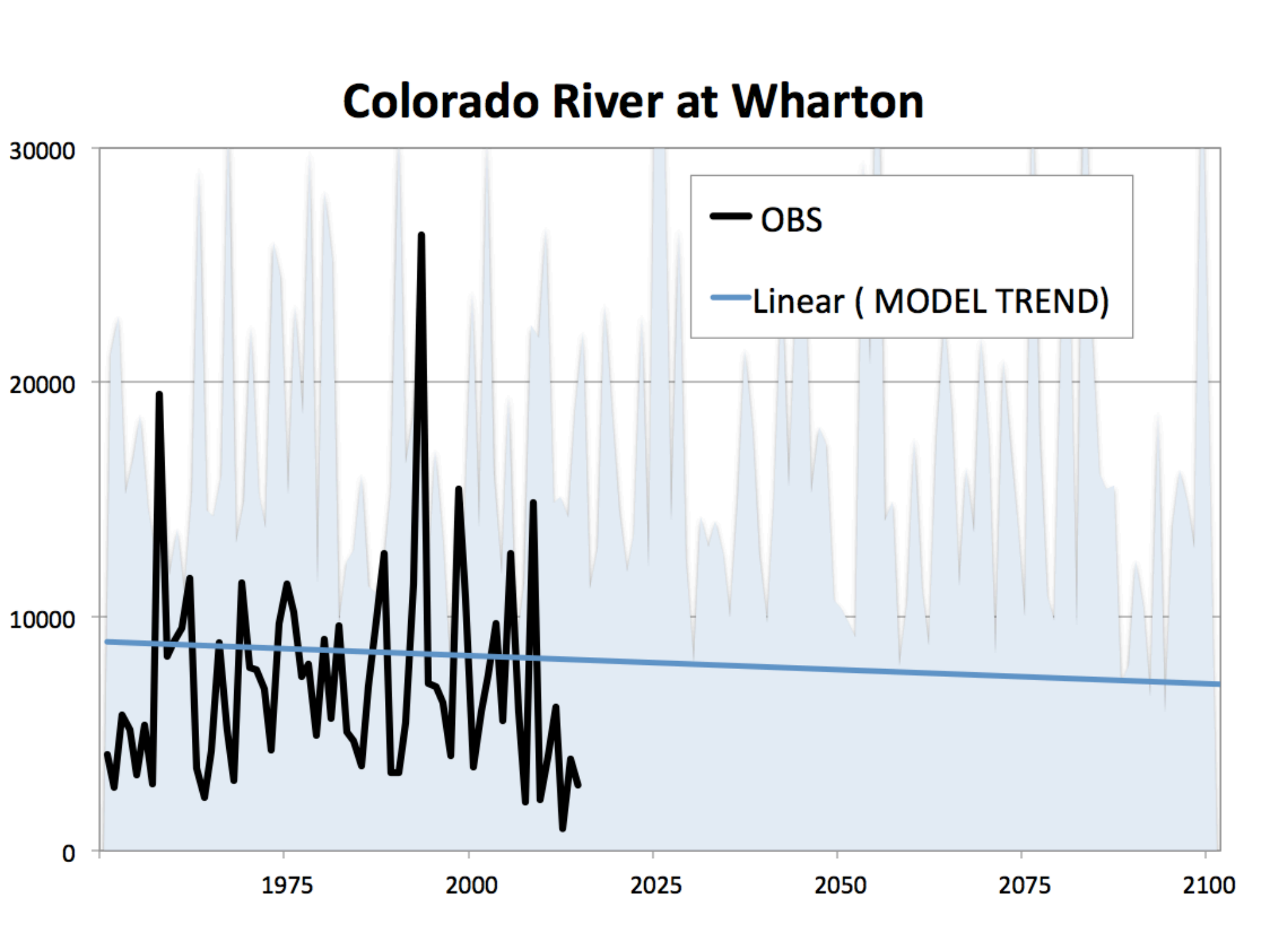


Lowest 3 Years of Streamflow
Colorado River at Austin

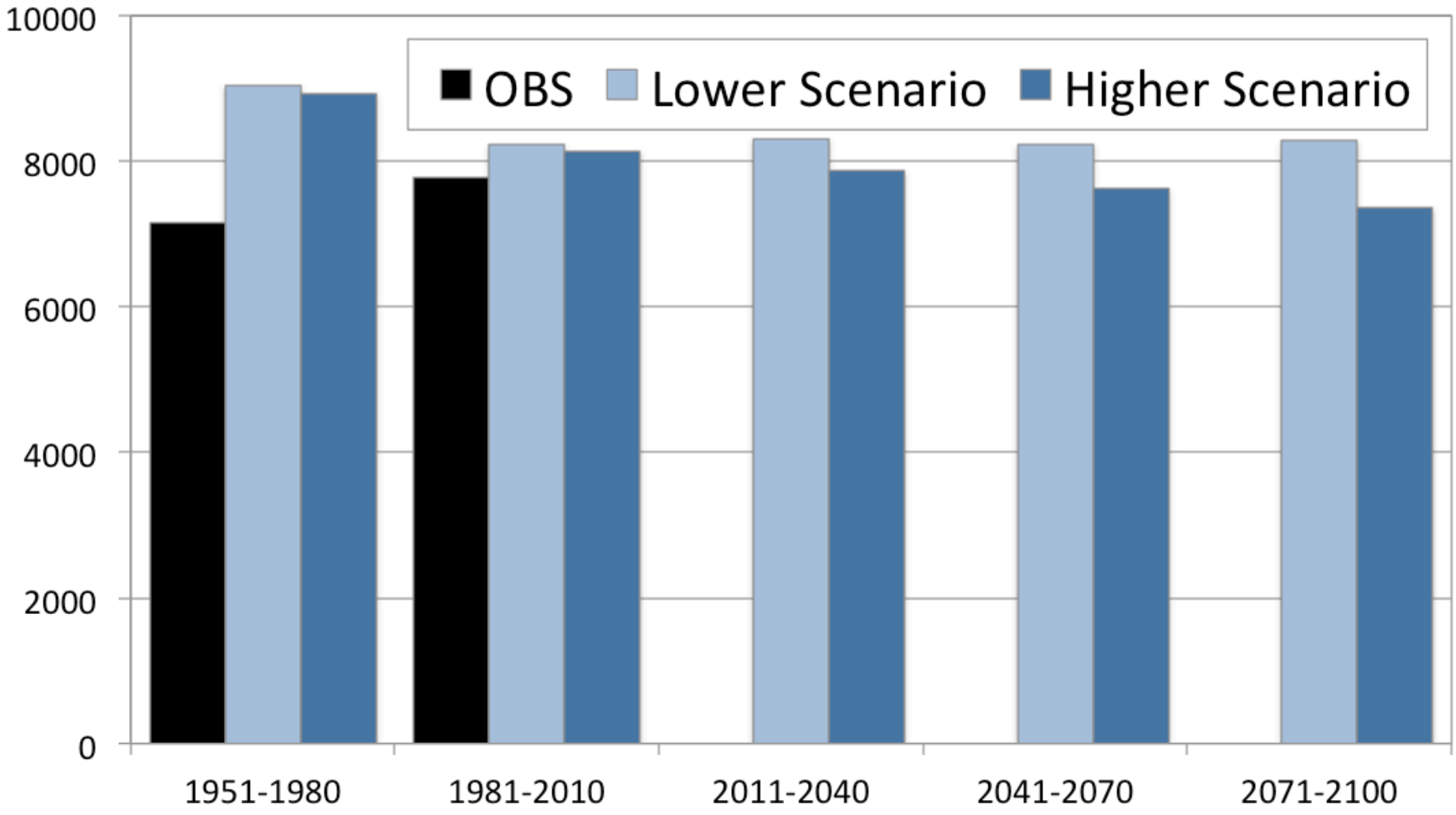


Highest 3 Years of Streamflow
Colorado River at Austin

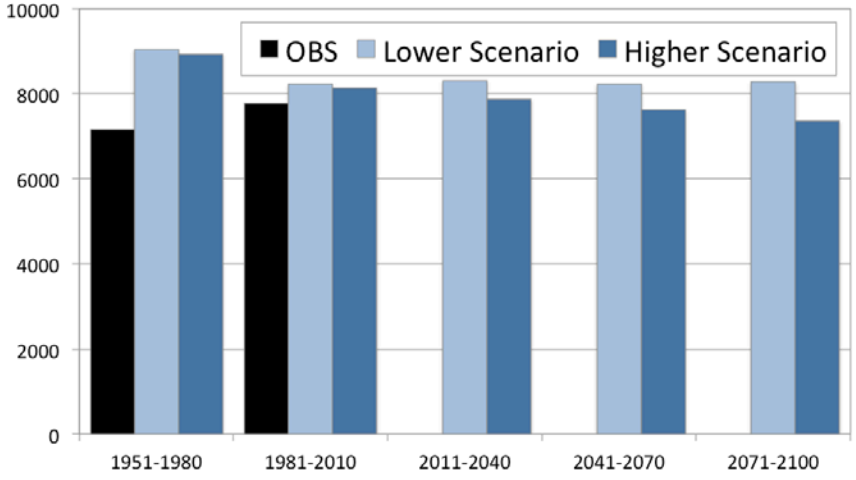



Colorado River at Wharton
30000
20000
10000
0
1975
2000
2025
2050
2075
2100
OBS
Linear (MODEL TREND)

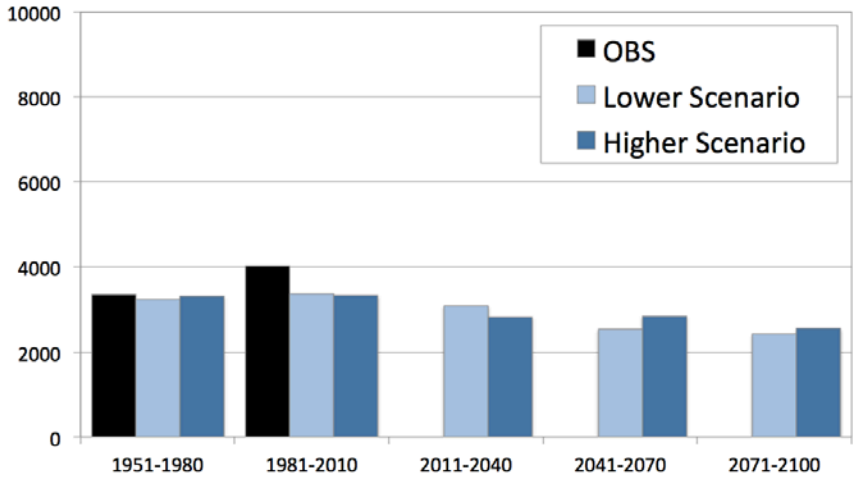
Annual Streamflow
Colorado River at Wharton



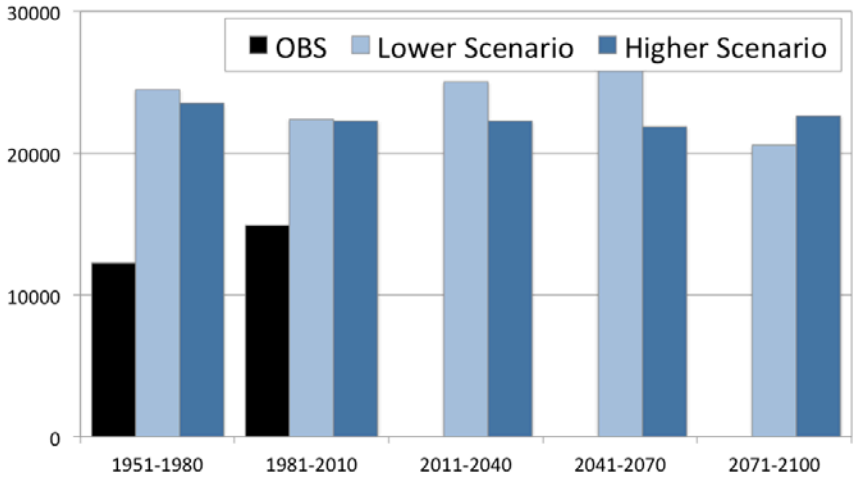
Annual Streamflow
Colorado River at Wharton



Lowest 3 Years of Streamflow
Colorado River at Wharton



Highest 3 Years of Streamflow
Colorado River at Wharton



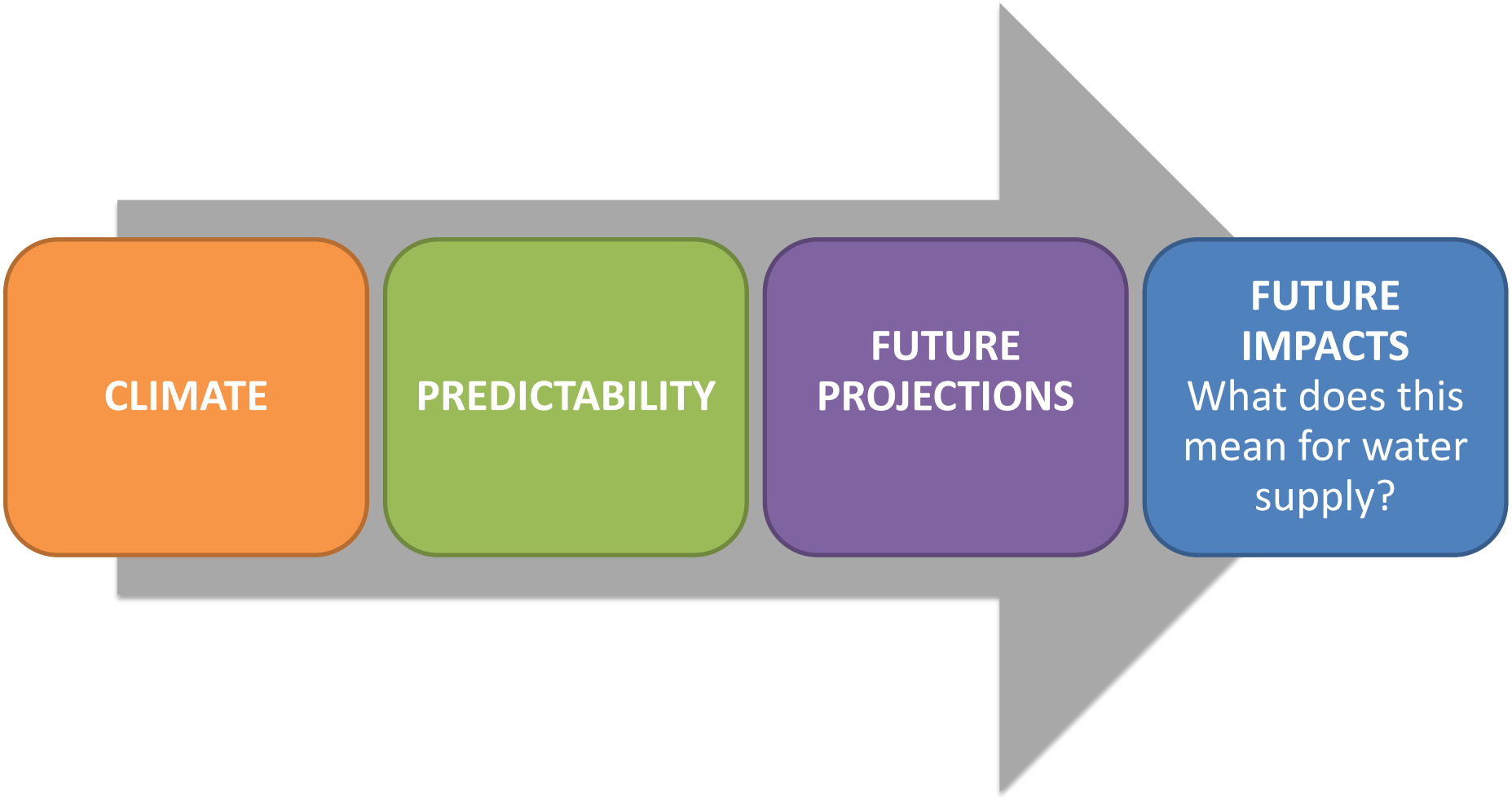
NEXT STEPS

Develop seasonal models.

Finalize analysis results.

Provide streamflow inputs to the WAM gauges for 1950-2100.

Provide monthly precipitation and evaporation for the TWDB quadrangles.


CLIMATE
PREDICTABILITY
FUTURE PROJECTIONS
FUTURE IMPACTS
What does this mean for water supply?

Austin WATER