

The Changing Gila River: Past, Present, and Future

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David Gutzler is a Professor in the Earth & Planetary Sciences Department at UNM. He and his students study climate variability and change, with an emphasis on analysis and prediction of climate and surface hydrology variability on time scales of seasons to decades. He has a PhD degree in meteorology from MIT, and is a former editor of the American Meteorological Society's Journal of Climate.



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- How is the hydrograph on the upper Gila projected to change as climate warms up?
- Snowmelt runoff?
Summer low flows?
- We'll use observations, coupled dynamical models, and simple statistical models
- Three ISC technical reports (2013, 2015, 2016)

New Mexico Water Conference
October 6, 2016

Figure 1. Introduction.

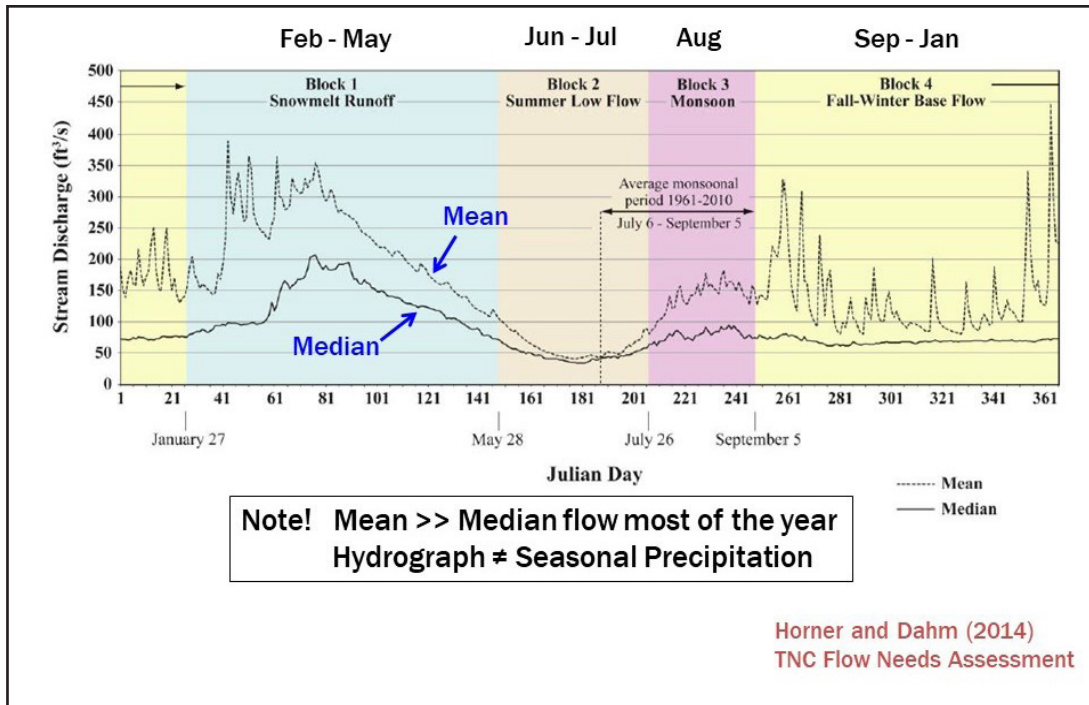


Figure 2. Average annual hydrograph for the Upper Gila River.

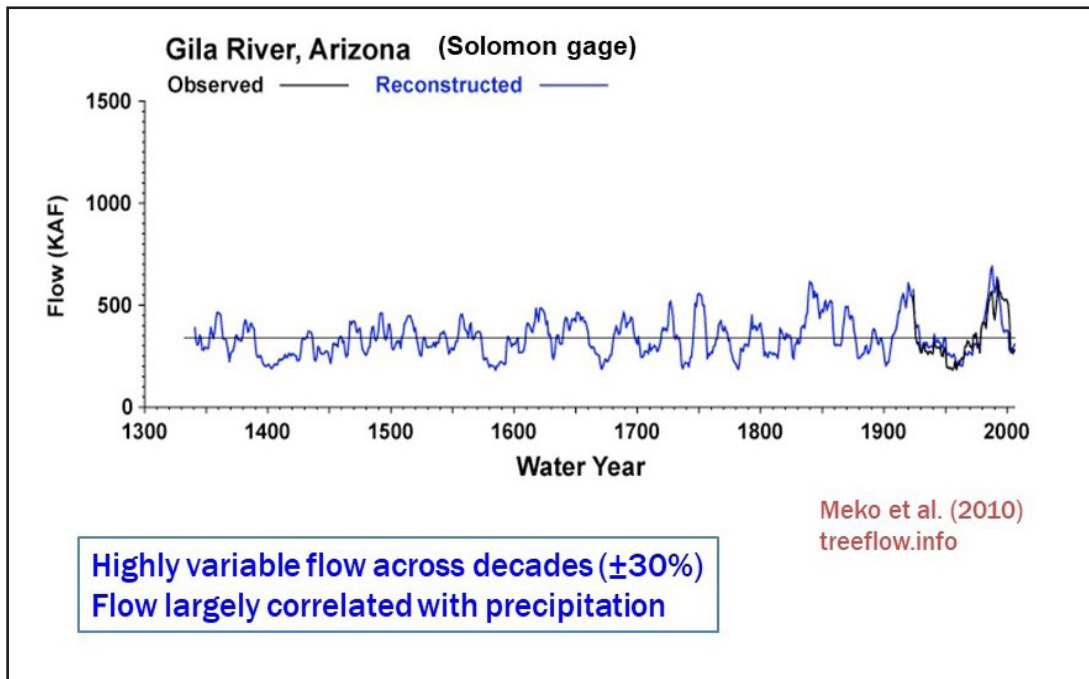


Figure 3. Reconstructed past flows.

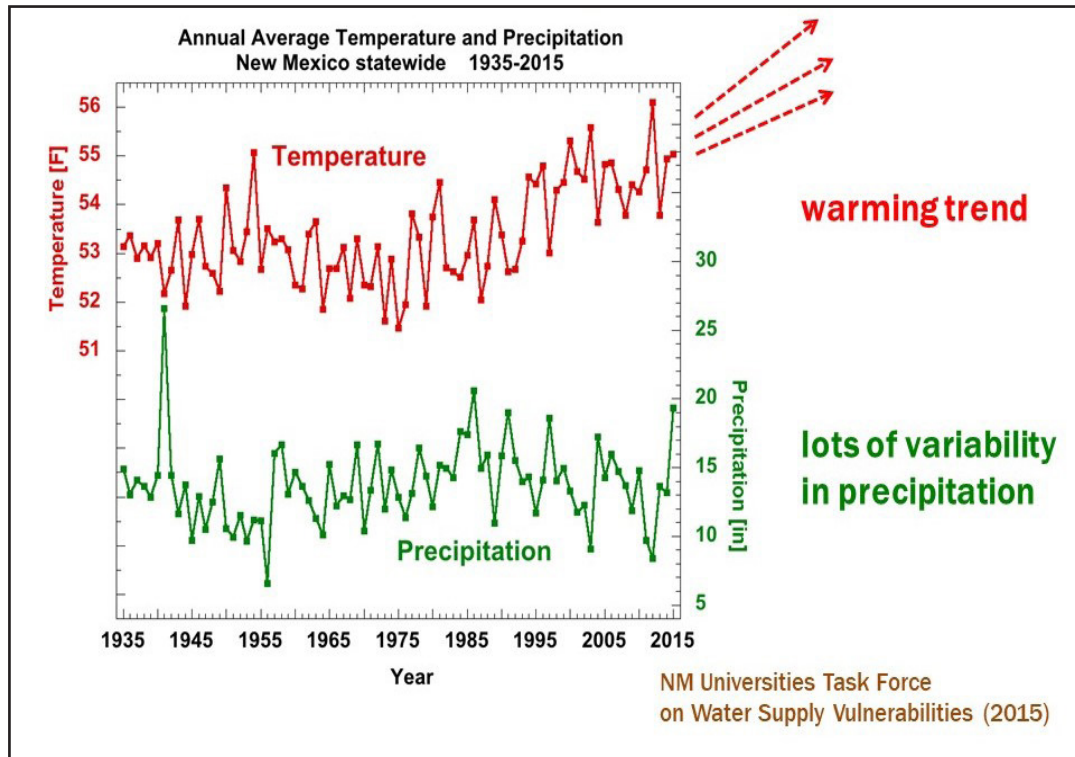


Figure 4. Observed climate variability and change in New Mexico.

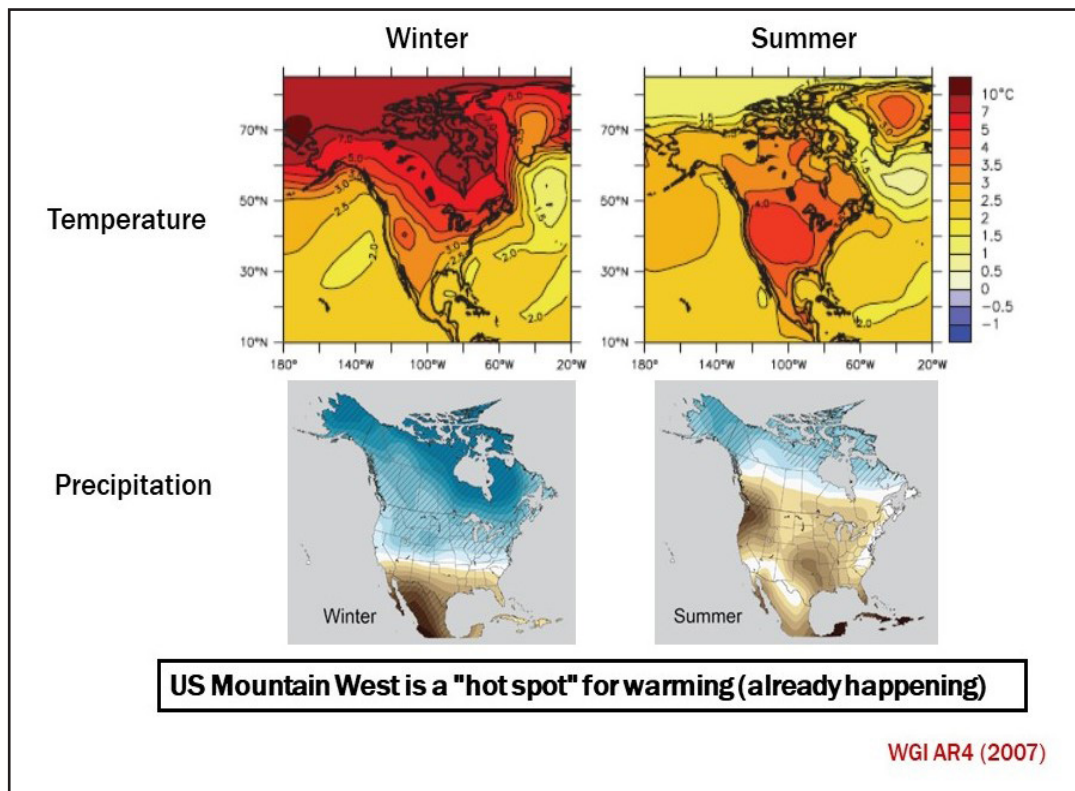


Figure 5. Projected climate change in the 21st century.

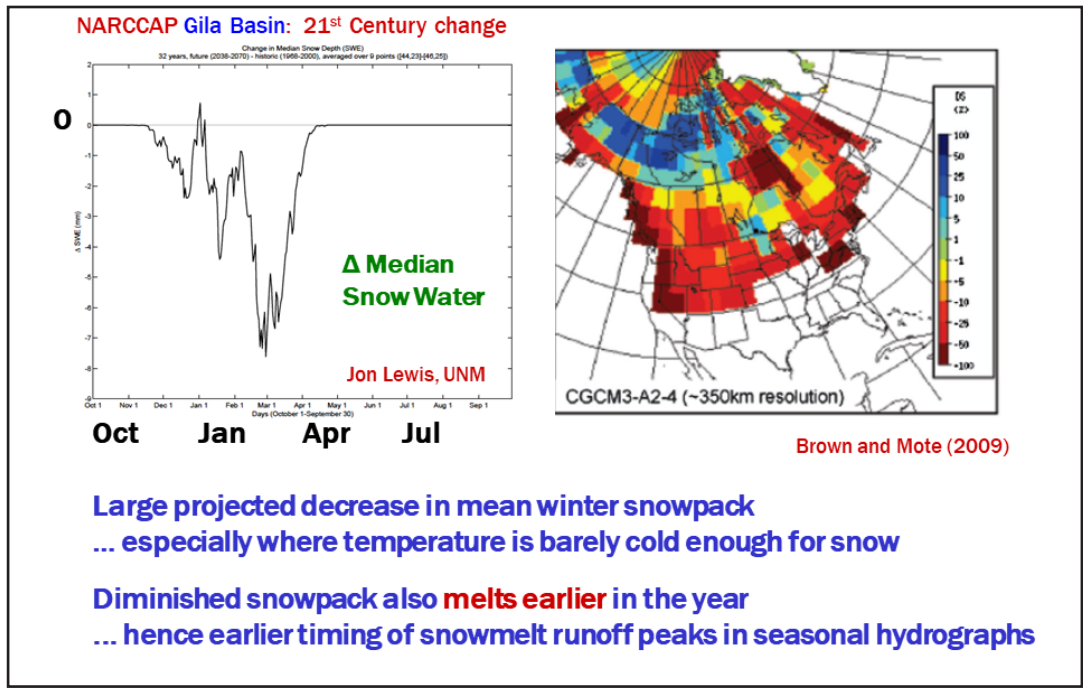


Figure 6. The big projected change of decreasing snowpack.

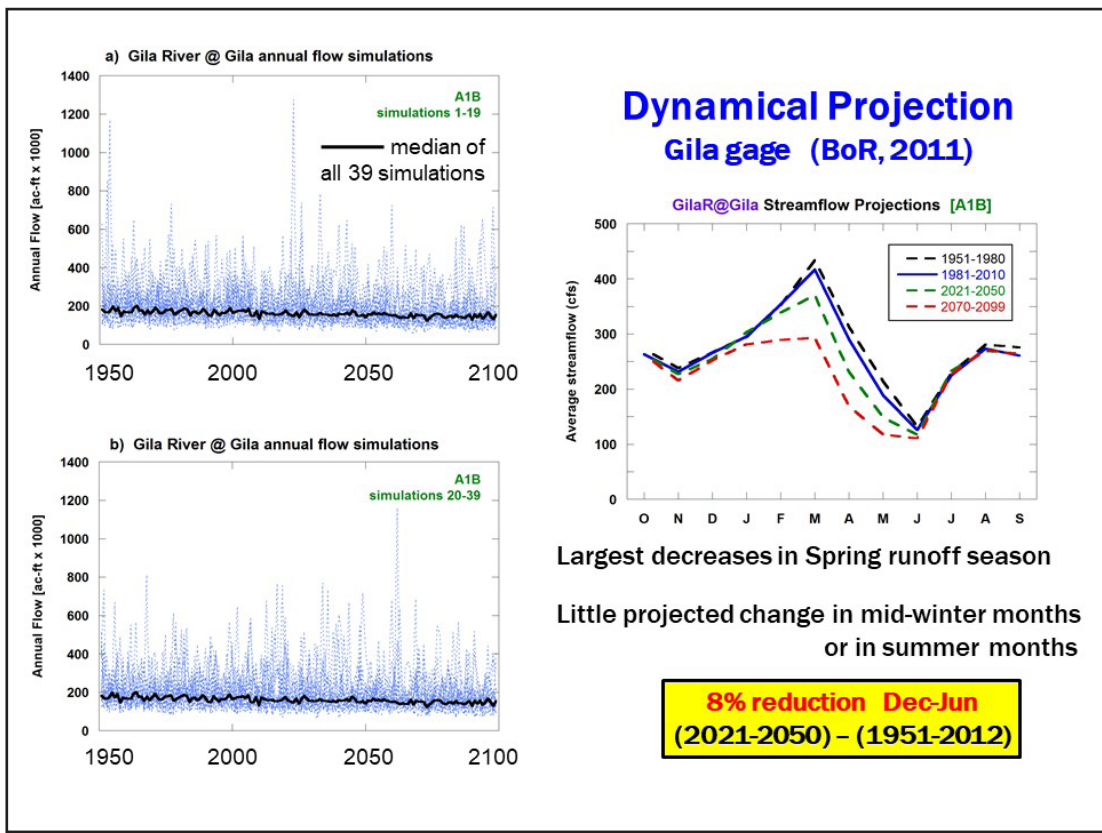


Figure 7. Dynamical projection of Gila gage.

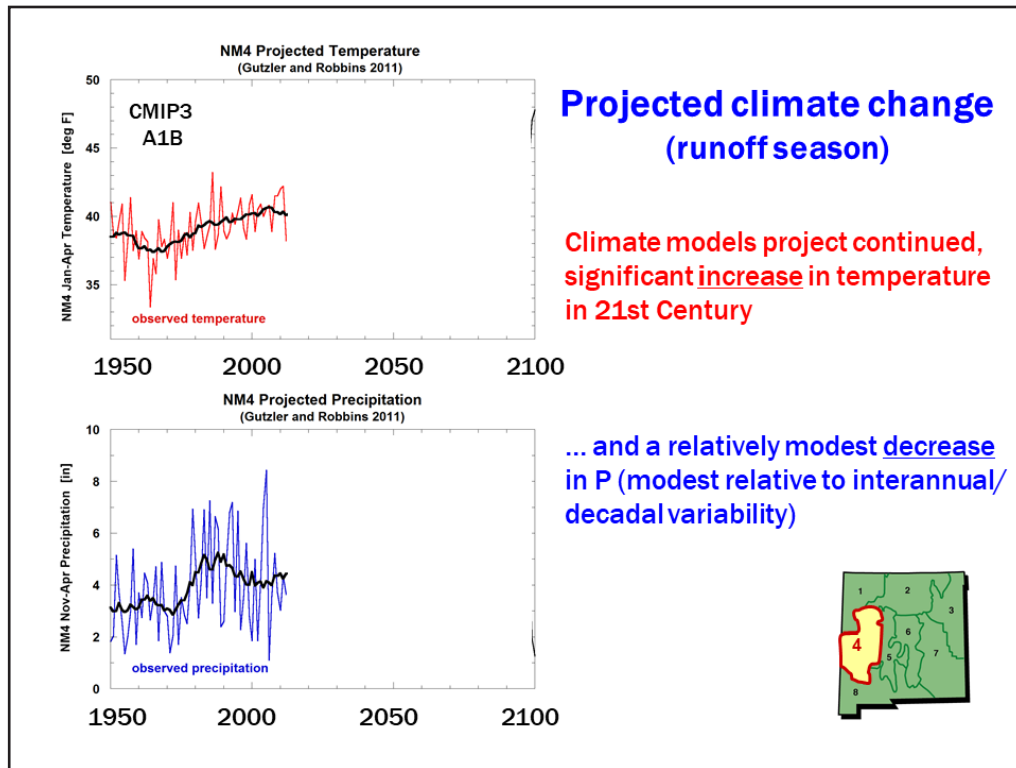


Figure 8. Projected climate change.

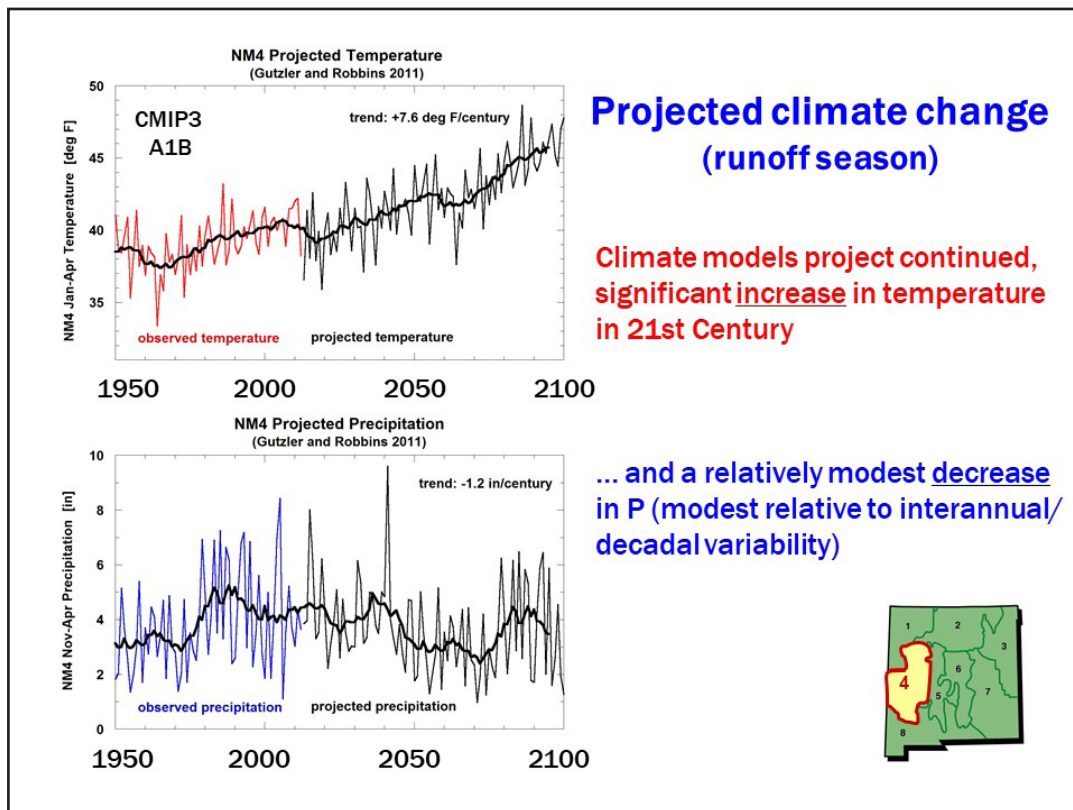


Figure 9. Projected climate change (cont.).

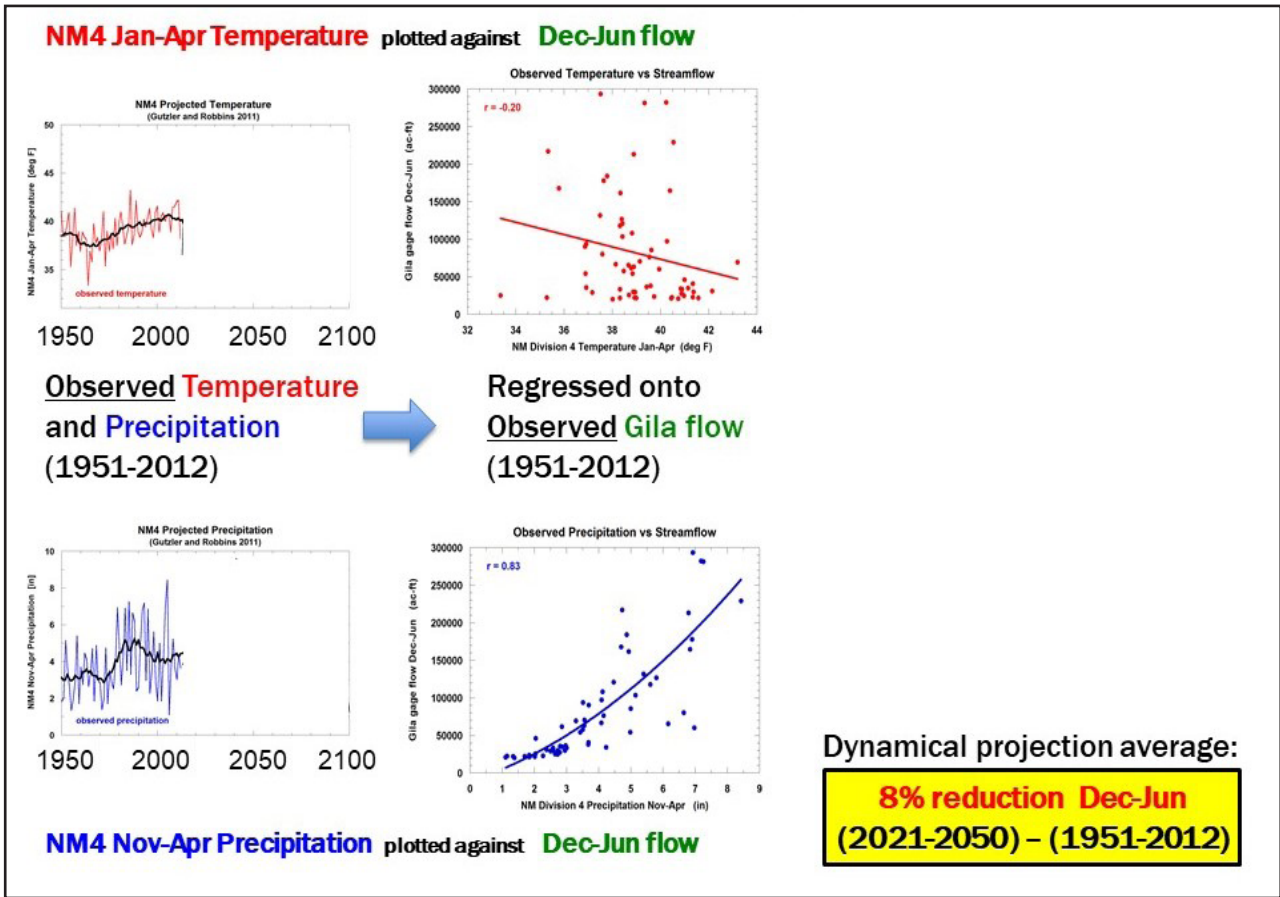


Figure 10. Statistical projection of the Gila gage during runoff season.

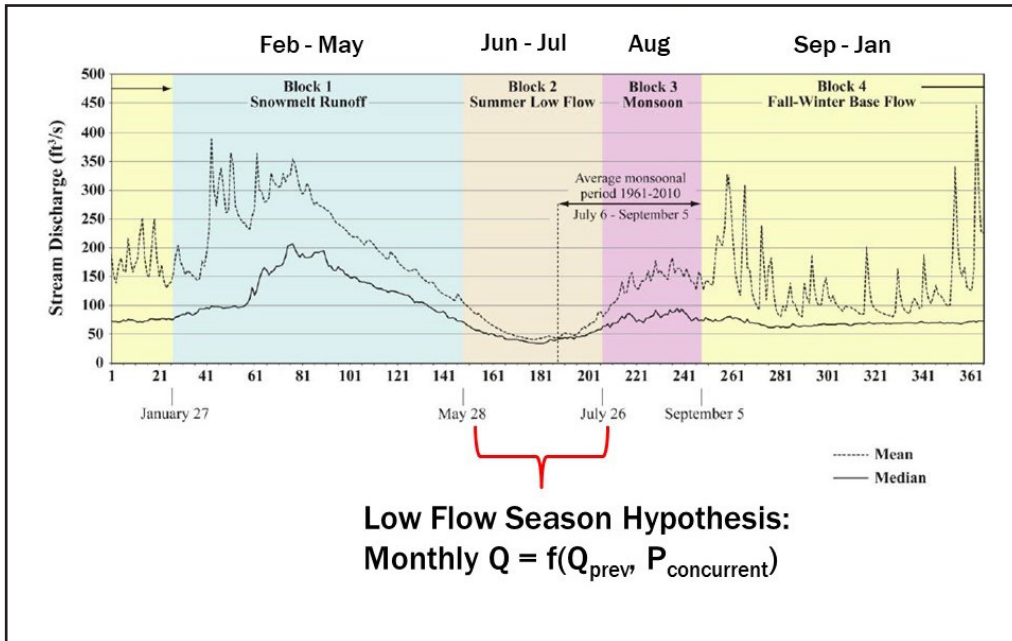


Figure 11. Future of low flows in the upper Gila basin.

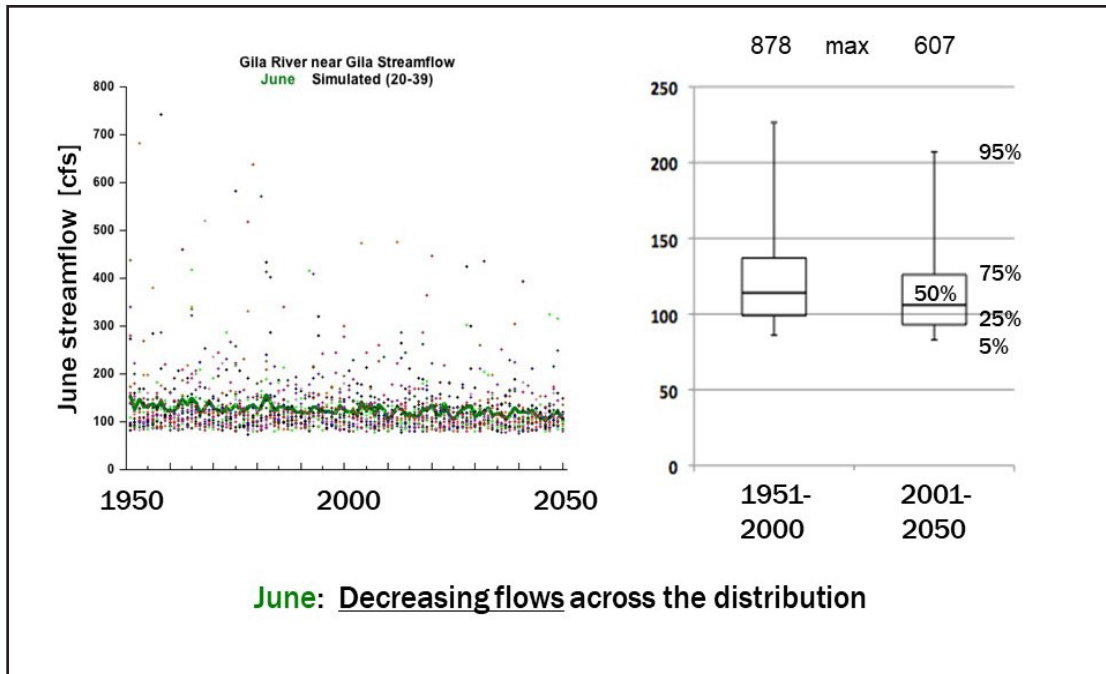


Figure 12. June streamflow.

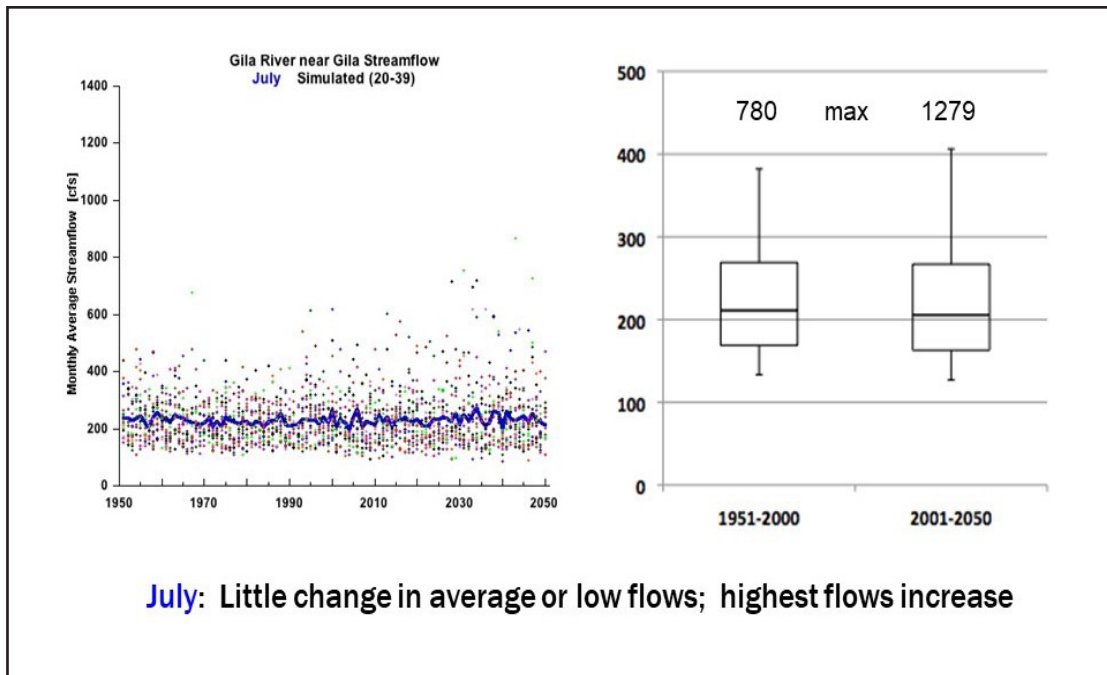


Figure 13. July streamflow.

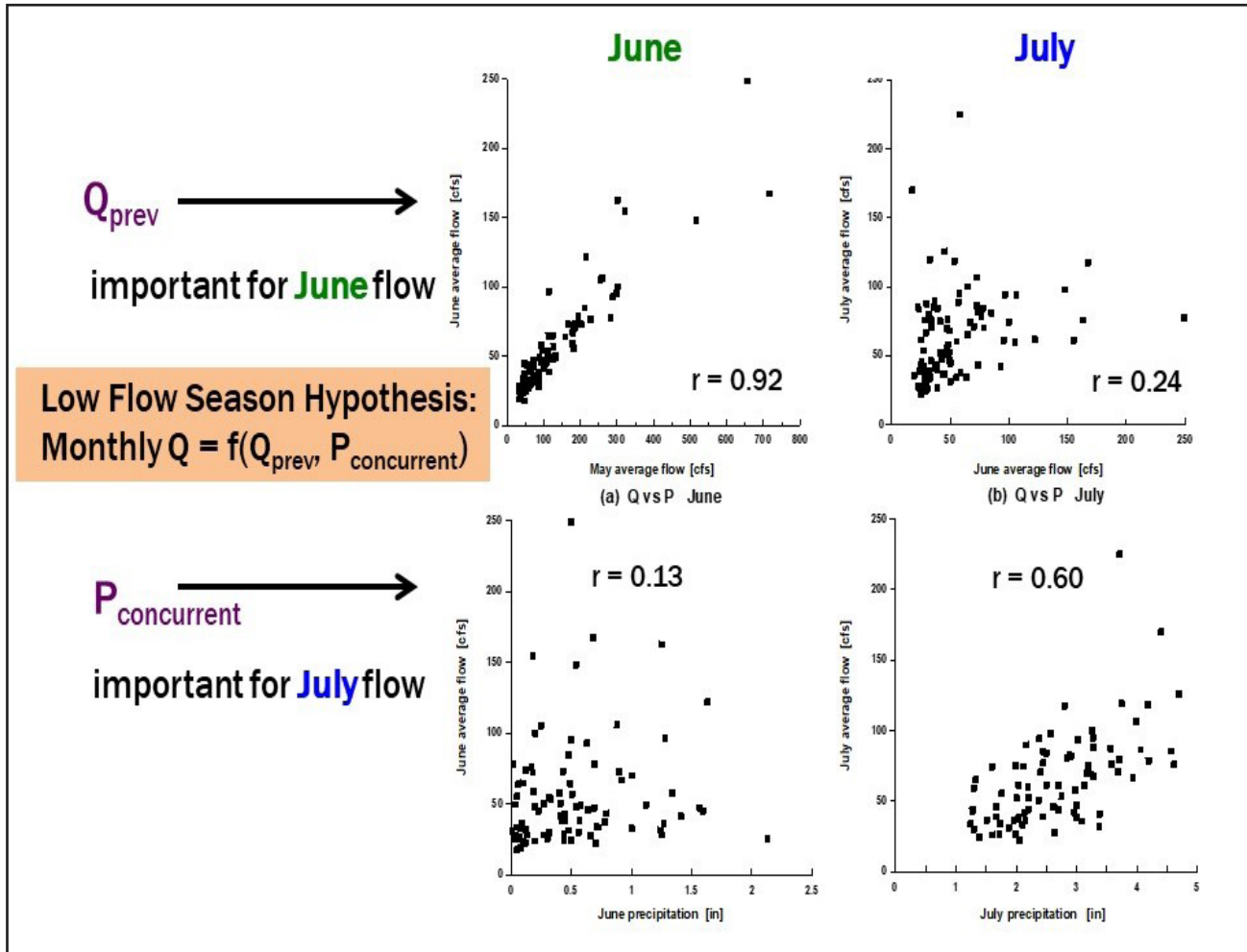


Figure 14. Predictors of observed low-flow monthly streamflow.

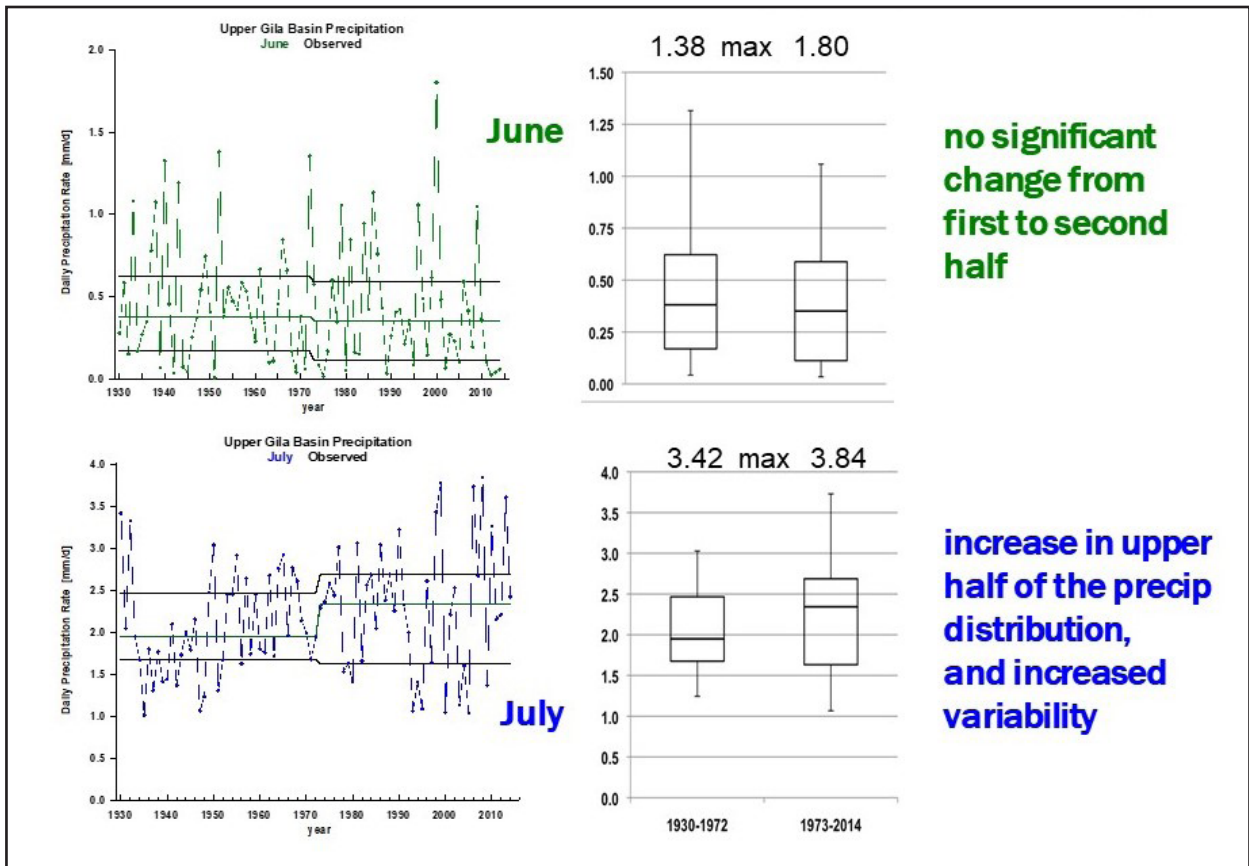


Figure 15. Low-flow months: observed precipitation variability.

- 1) Big projected temperature change (continuation of observed trend)
- 2) ~5-10% projected decrease in Upper Gila River snowmelt runoff (2021-2050) due to climate change
... relative to ~30% decadal variability due to natural precip fluctuations
- 3) Lowest flows and principal low-flow season changes projected in June
Uncertain mean change in July, with higher variability
- 4) We can derive these results using multiple, complementary techniques
→ combining observations, dynamical and statistical models
- 5) What about other rivers in NM? Shaleene Chavarria's poster re URG

Thanks!

UNM students: John Carilli, Jon Lewis, Justin O'Shea
 NM Interstate Stream Commission
 US Bureau of Reclamation, The Nature Conservancy






Figure 16. Climate change and the Upper Gila River.

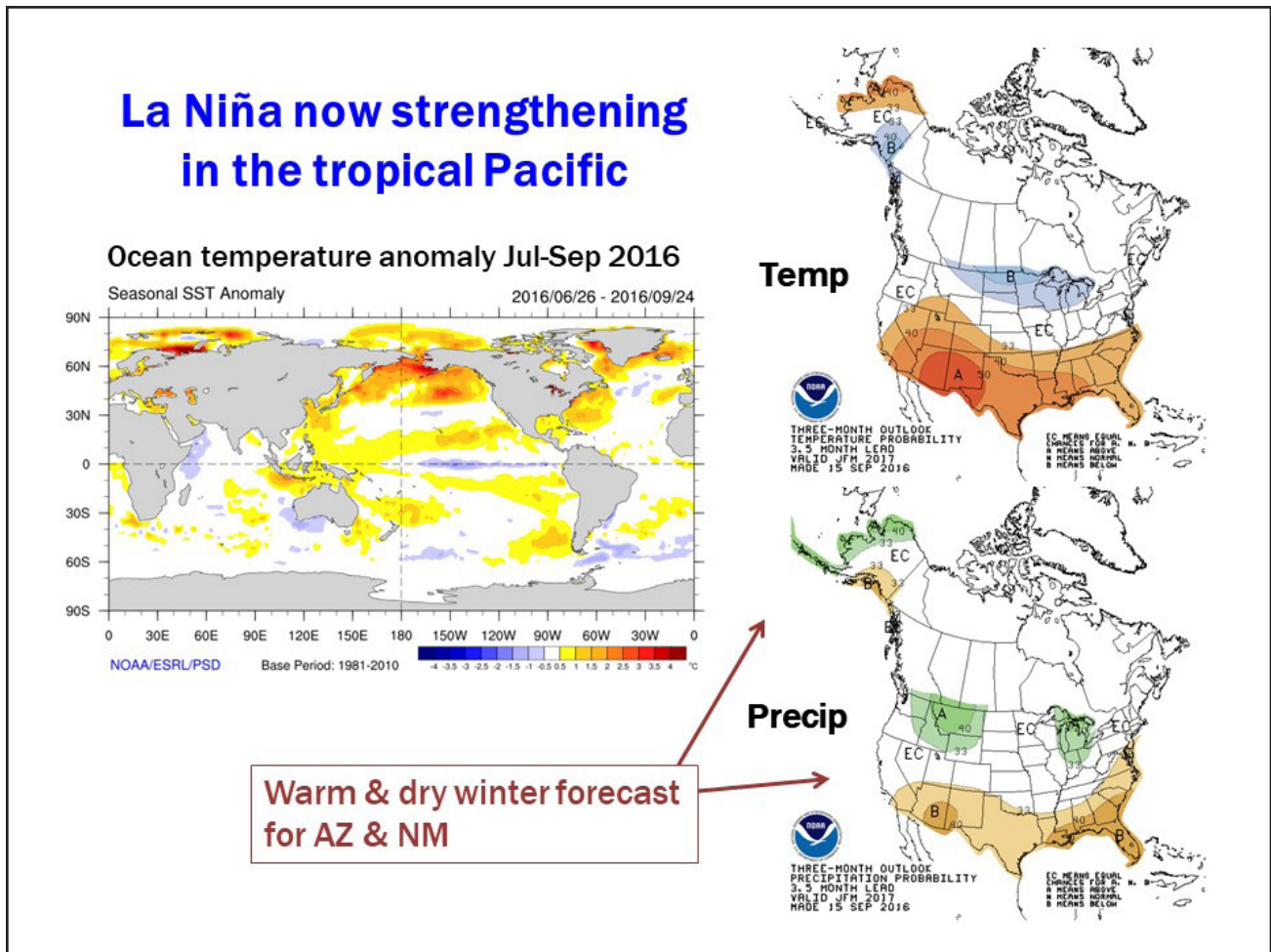


Figure 17. La Niña now strengthening in the tropical pacific.

Summary of principal results Garfin et al. (2014)		
Climate change		
	Confidence (my assessment)	Change by 2041-2070
Temperature ↑	high	3-4 °C/century
Snowpack ↓	high	not shown, but huge decrease
Precipitation total ↓	low	highly variable
Precipitation variability ↑	medium	more extreme events
Streamflow change		
	Confidence (my assessment)	Change by 2041-2070
Spring flow total ↓	high	} 6-19% decrease annual flow
Summer flow total ↓	low	
Earlier Spring runoff	high	
Short-term peak flows ↑	medium	~10% increase of upper 10%

Figure 18. Summary of principal results.

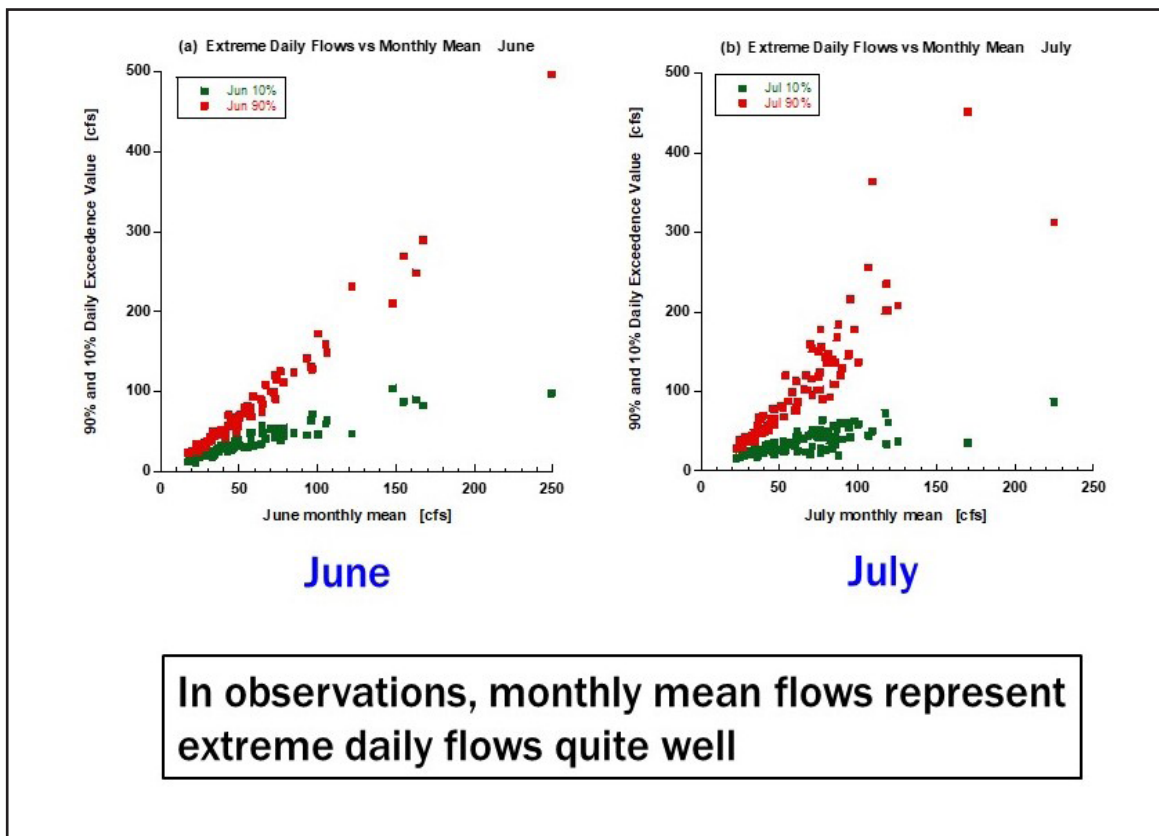


Figure 19. Monthly mean v. extreme flow.

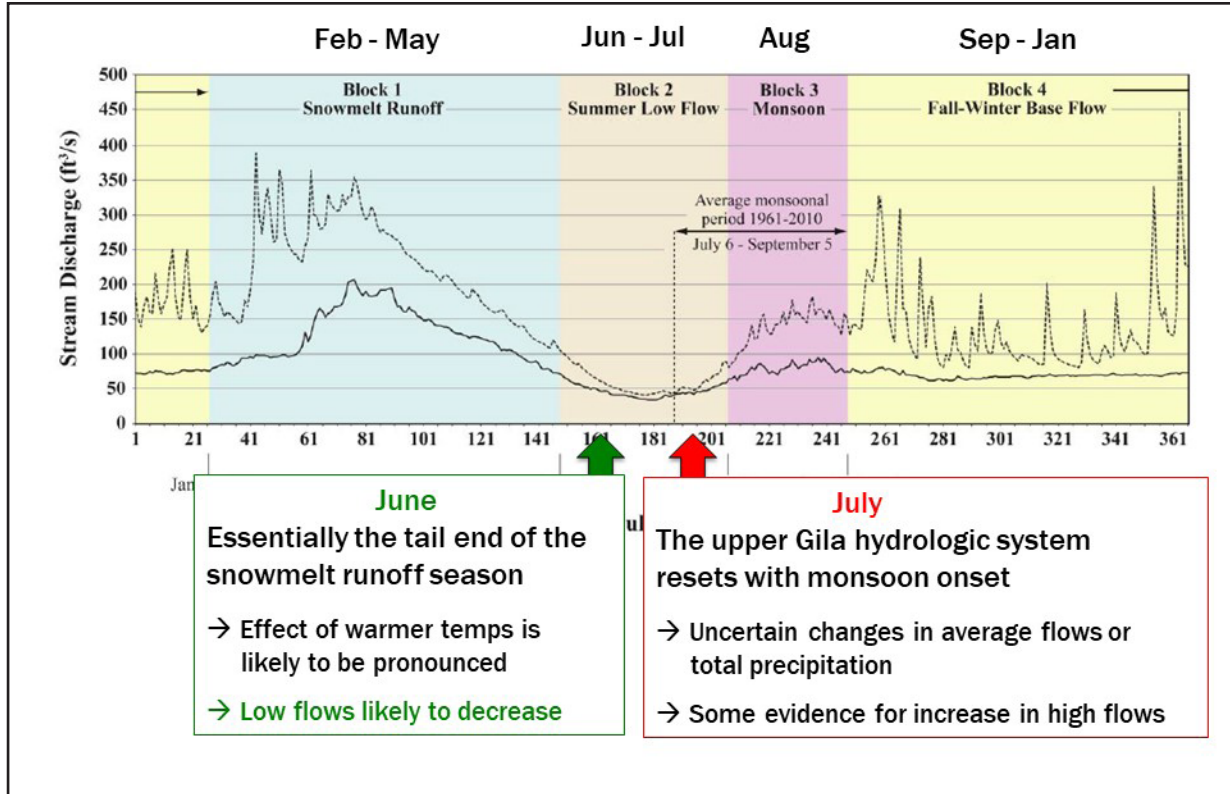


Figure 20. Future of low-flows in the upper Gila basin.

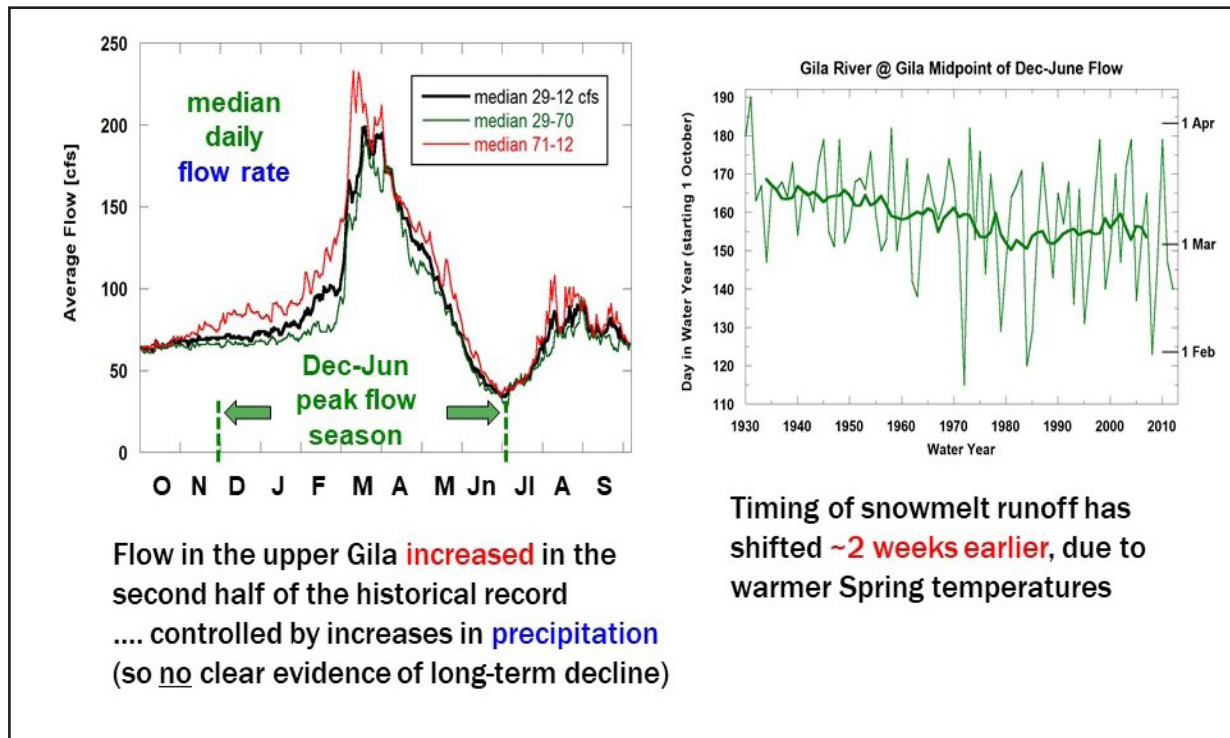


Figure 21. Evidence for projected changes in observed flow.

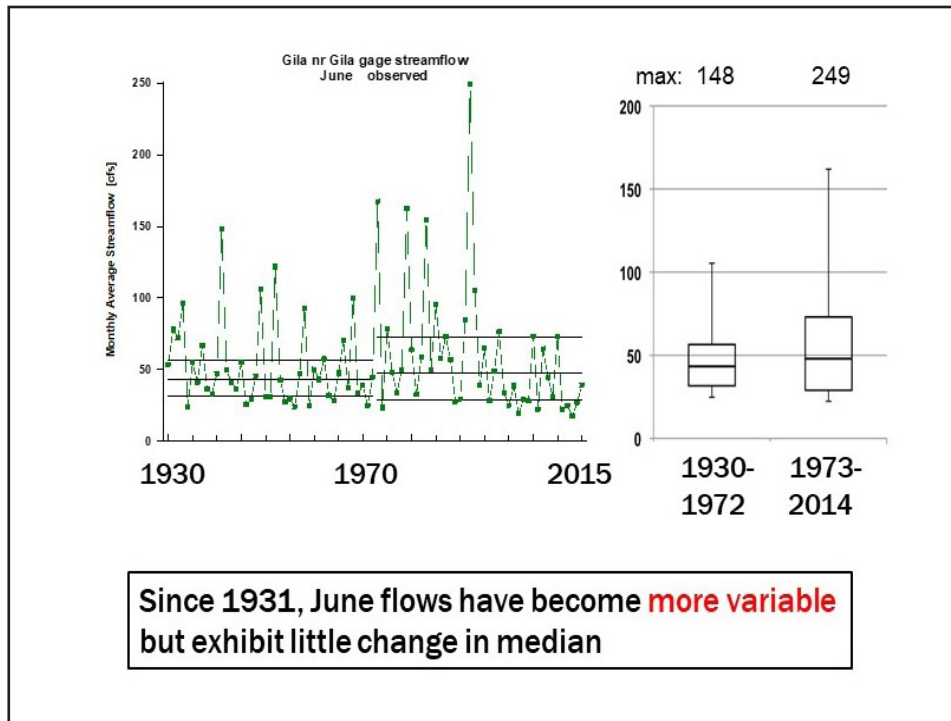


Figure 22. Observed evidence for decreasing flows in June.

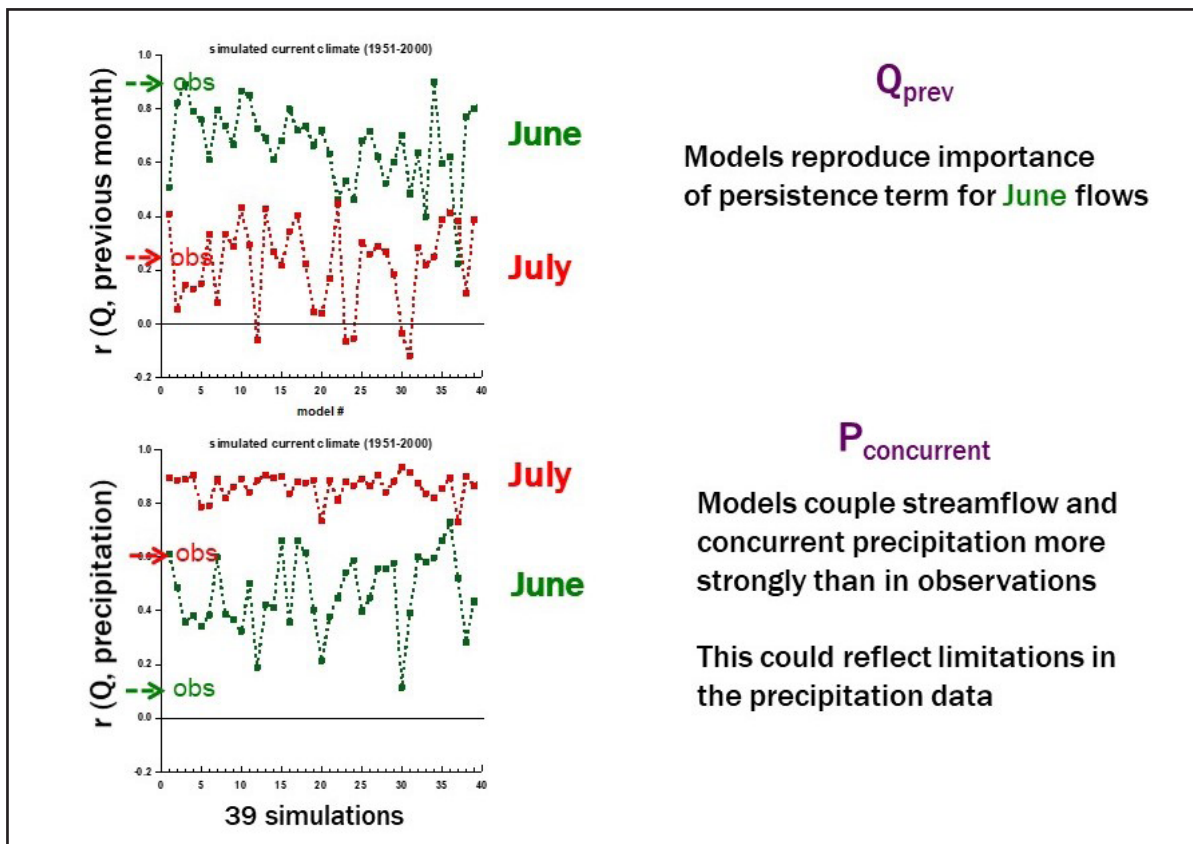


Figure 23. Predictors of simulated low-flow monthly streamflow.

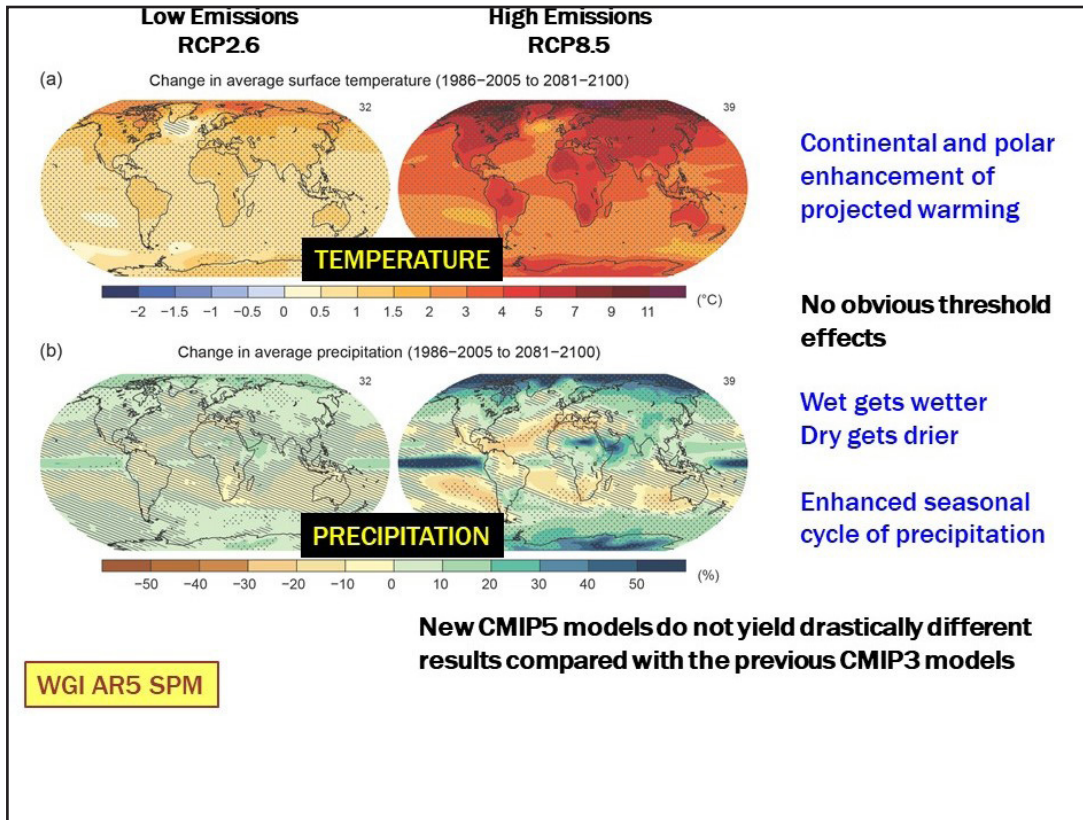


Figure 24. Projected 21st Century Changes.

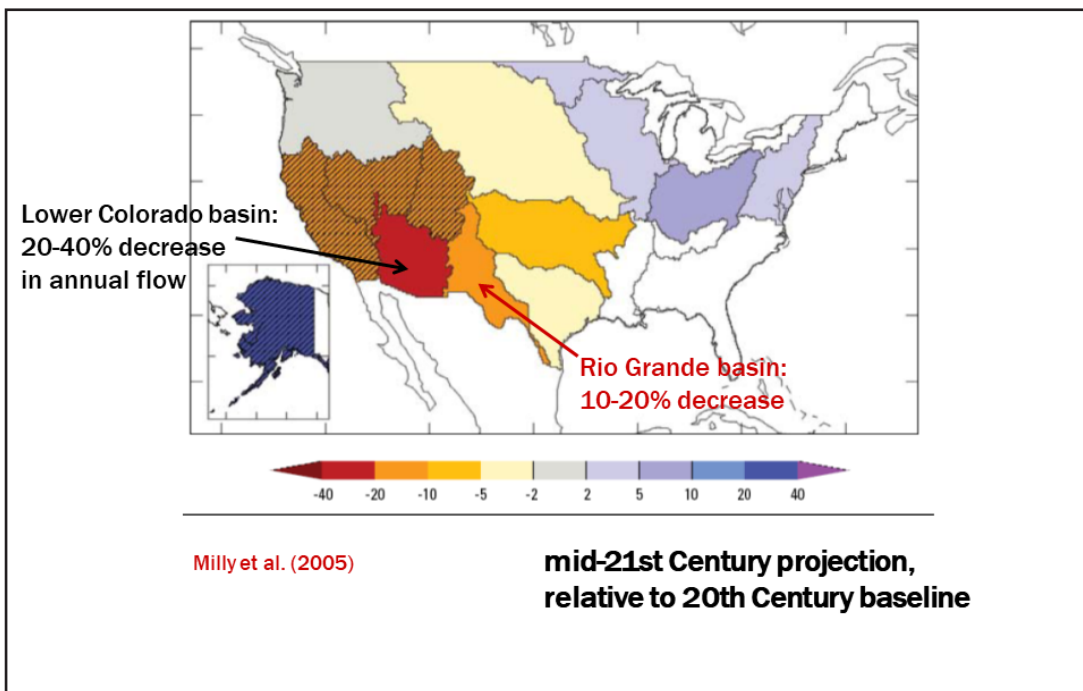


Figure 25. Projected streamflow changes North America.

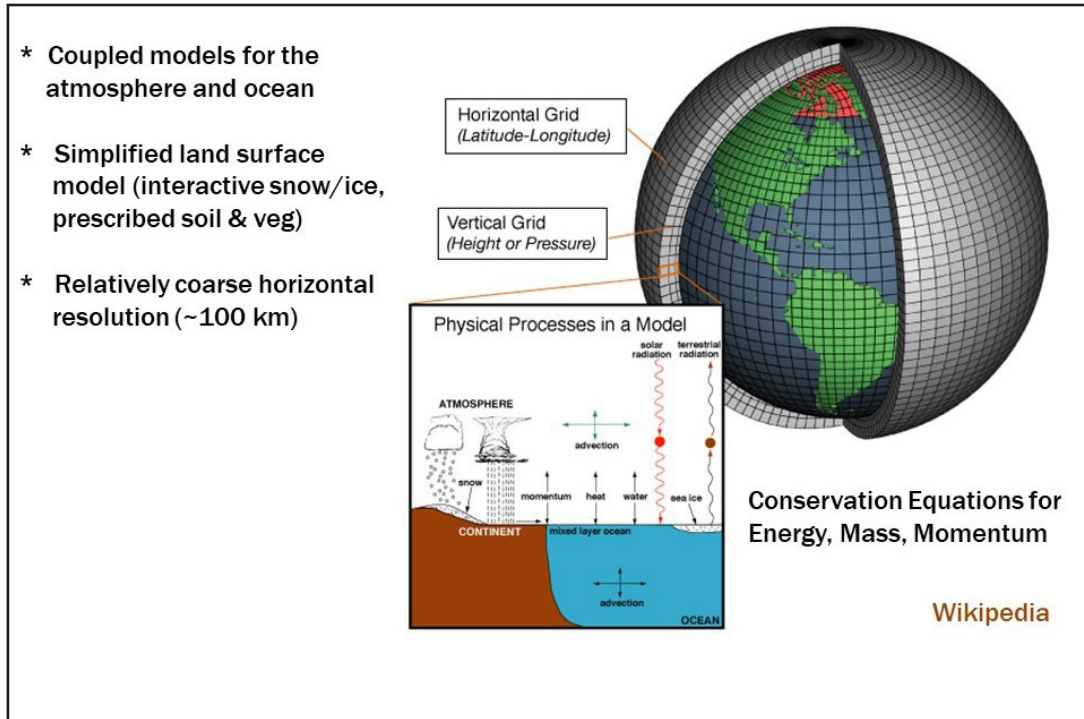


Figure 26. Global climate model.

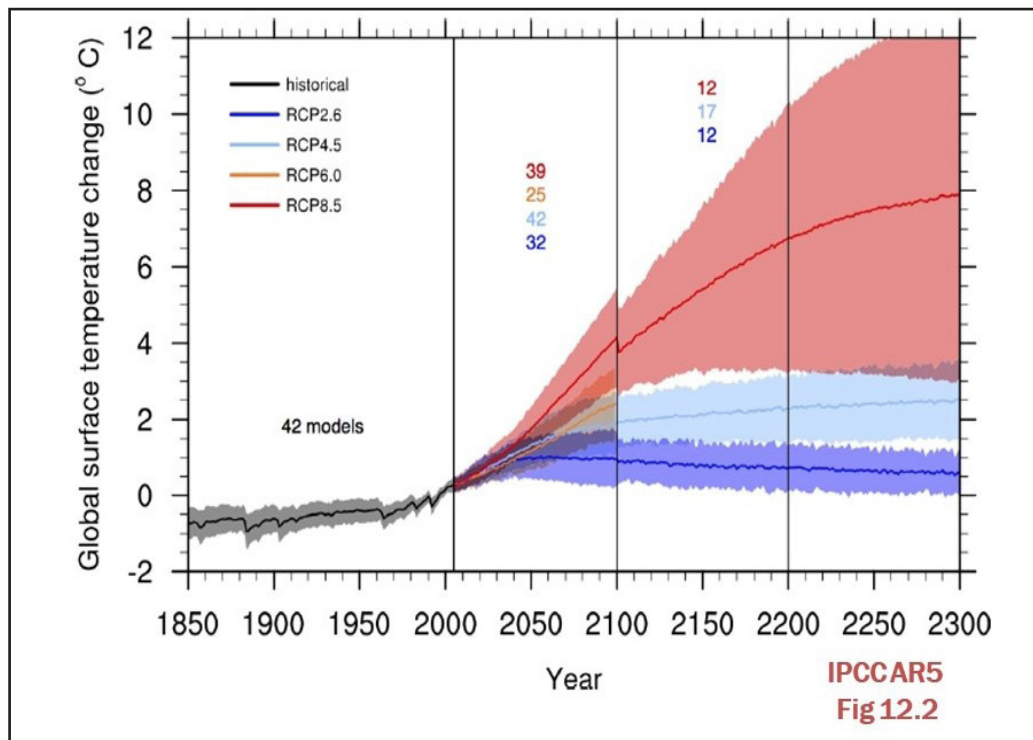


Figure 27. Projection of future global temperature change assuming that GHG increases are the dominant forcing.

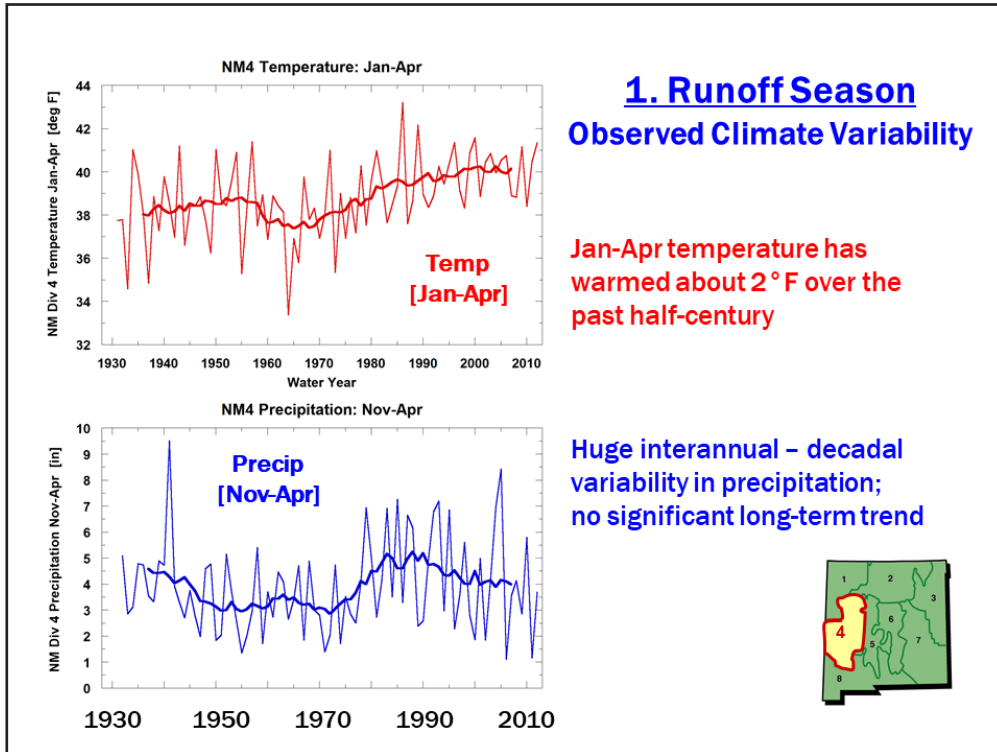


Figure 28. Observed climate variability during runoff season.

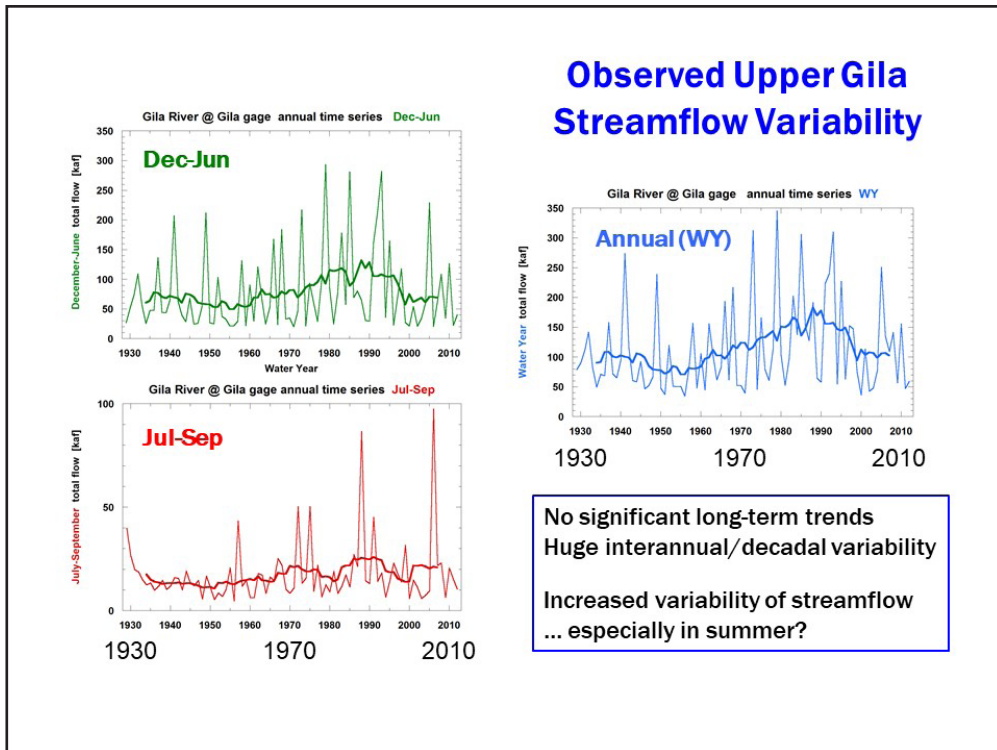


Figure 29. Observed streamflow variability in Upper Gila.

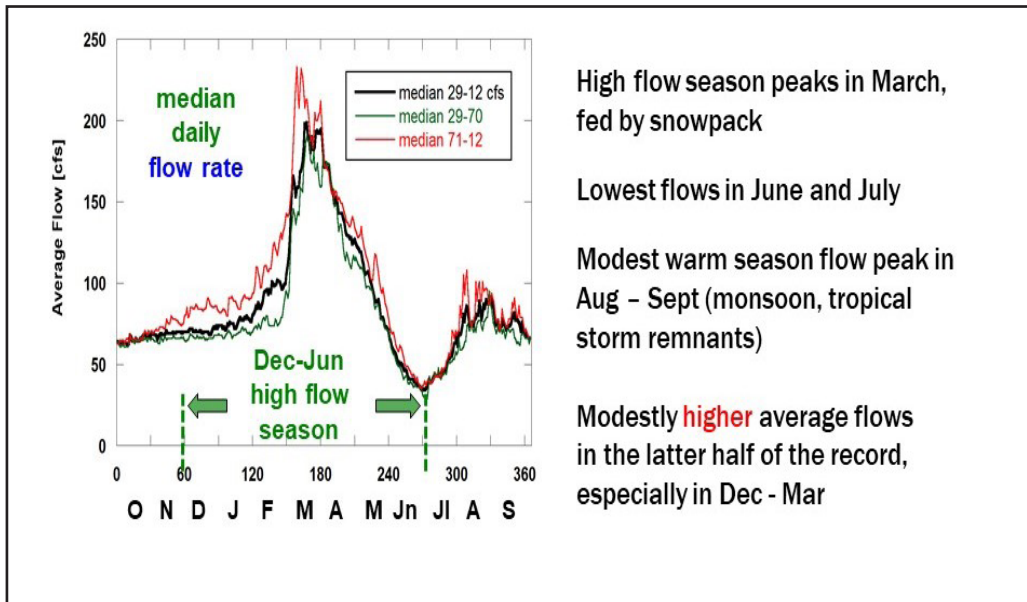


Figure 30. Gila gage at Upper Gila River.

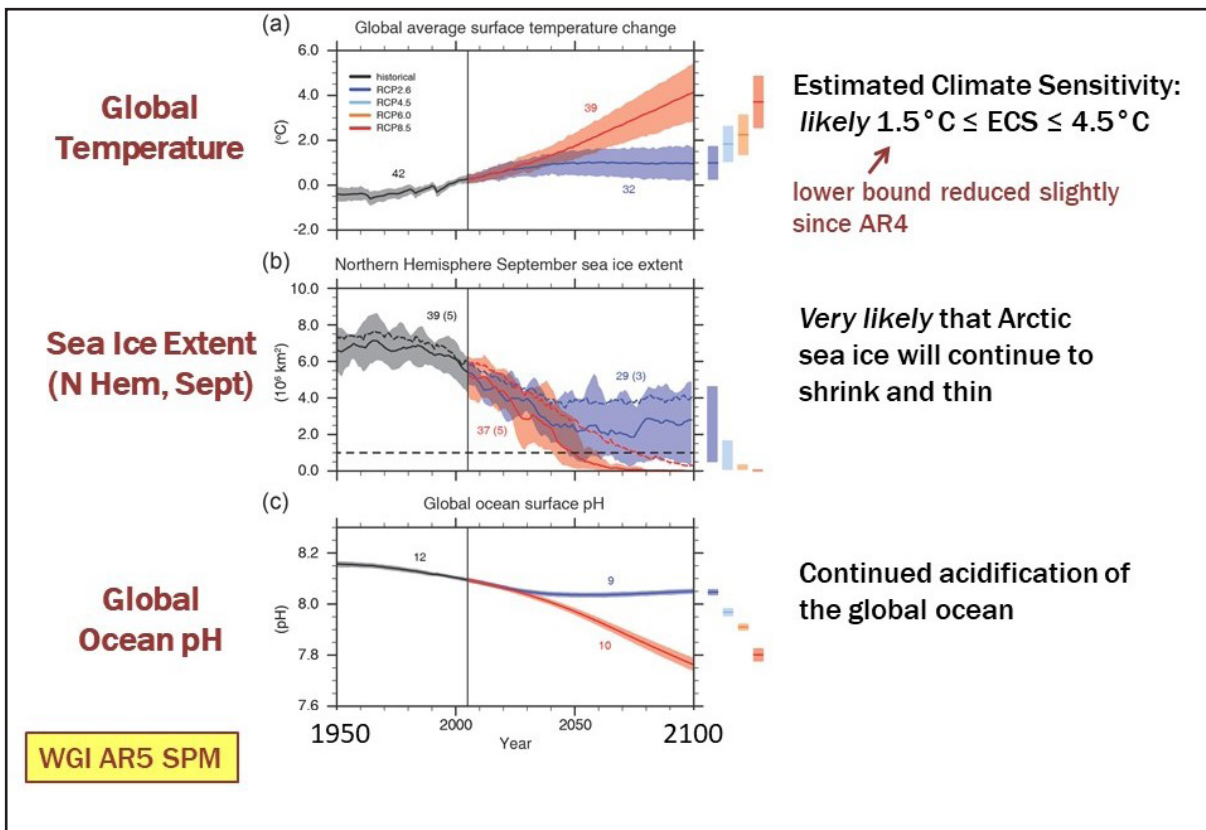


Figure 31. Projected 21st century changes.

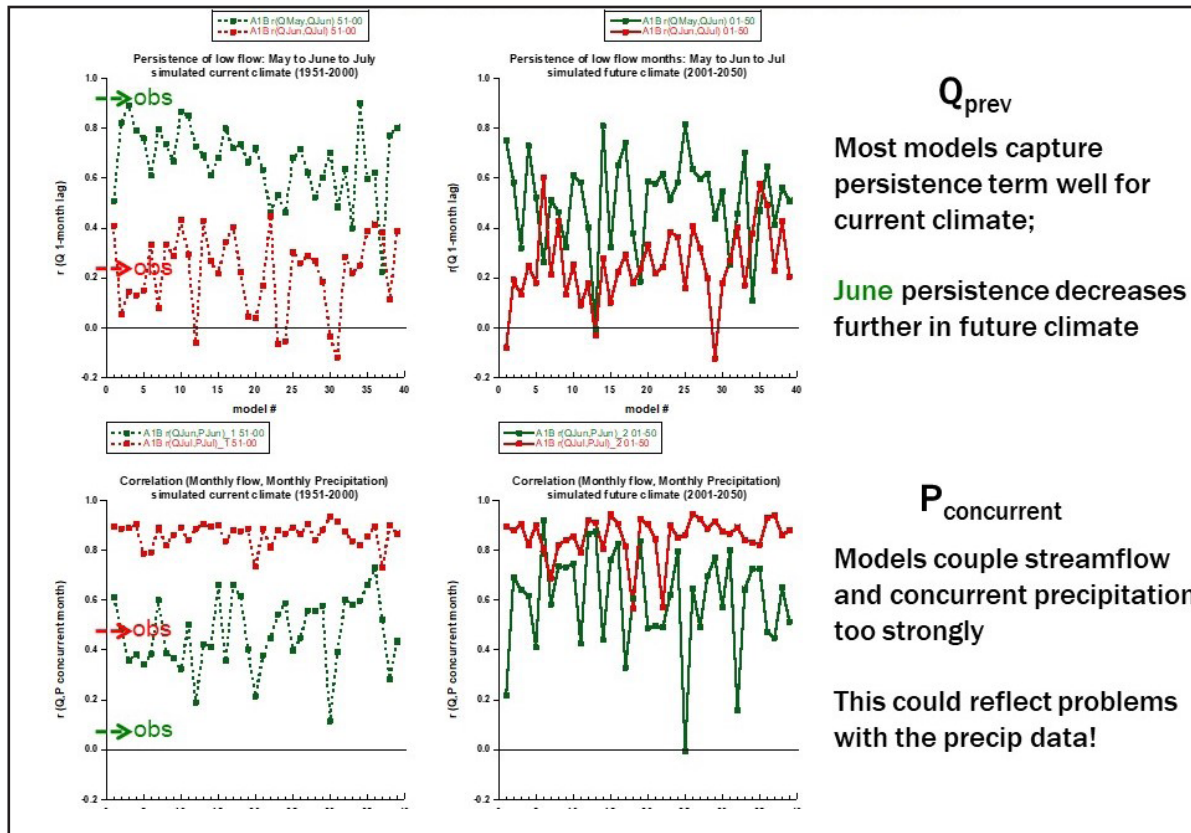


Figure 32. Month-to-month persistence of flow.

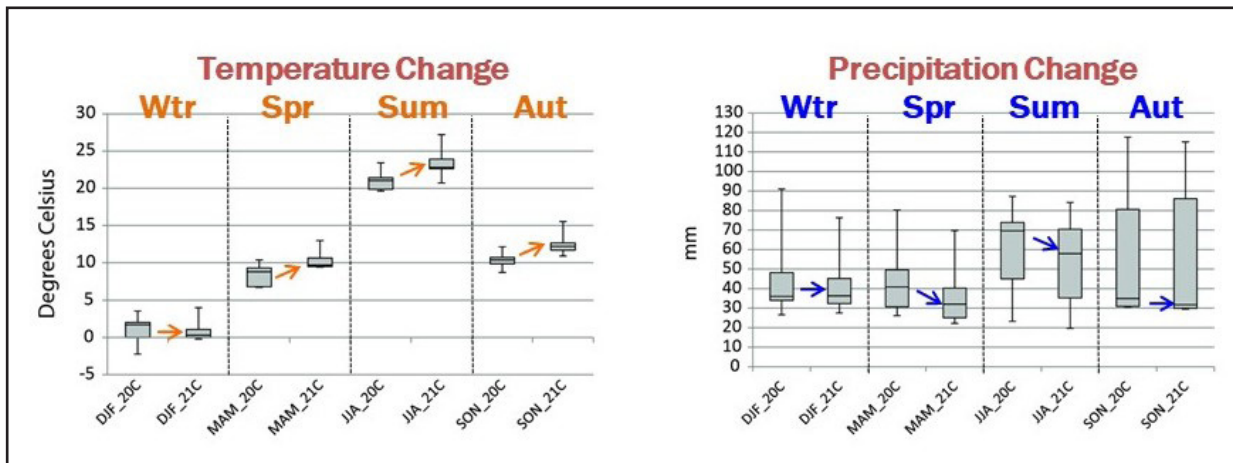


Figure 33. Garfin and others principal results: climate change.

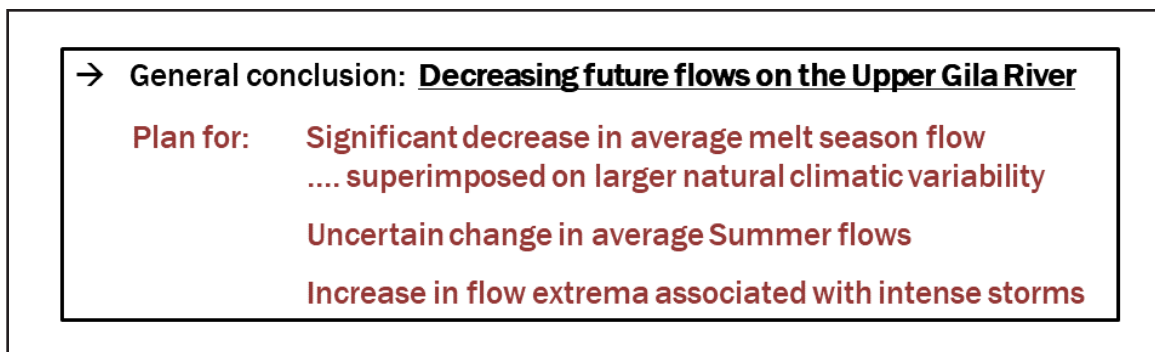


Figure 34. Conclusions: TNC Chapter 3 "Climate and Hydrology of the Upper Gila Basin."

