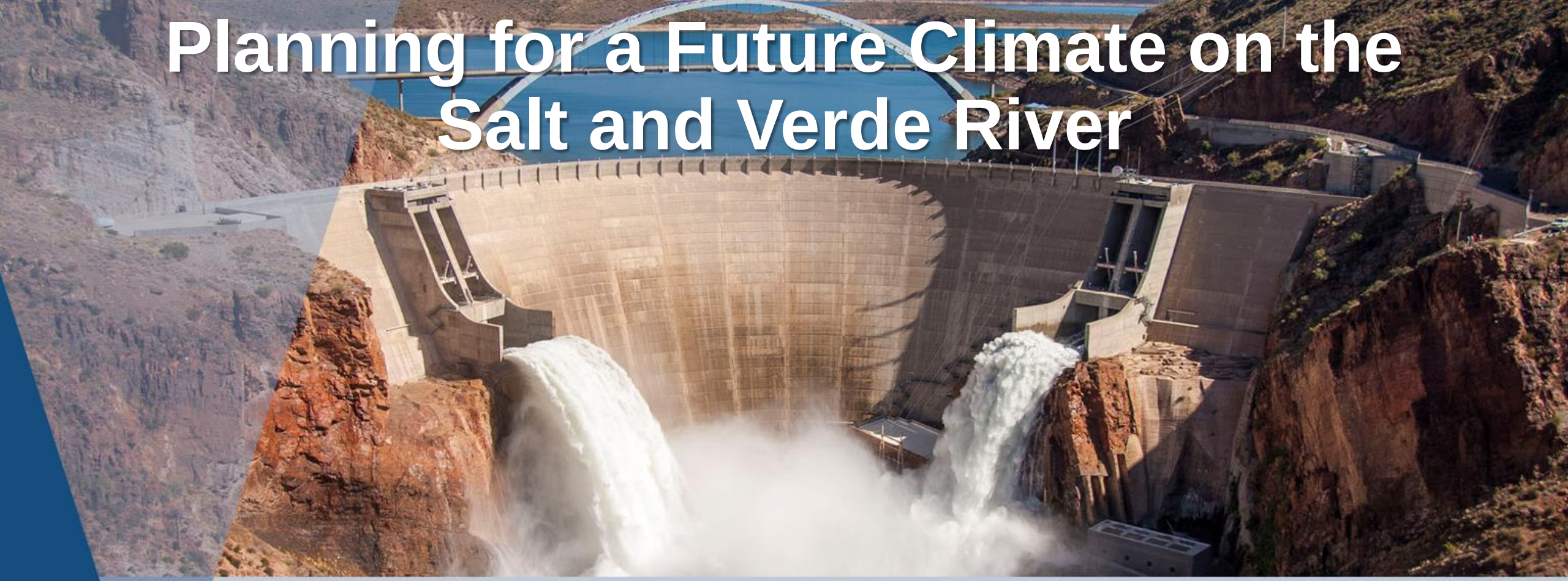
Planning for a Future Climate on the Salt and Verde River



James Walter
SRP Surface Water Resources

WESTCAS Annual Conference
June 20th, 2018

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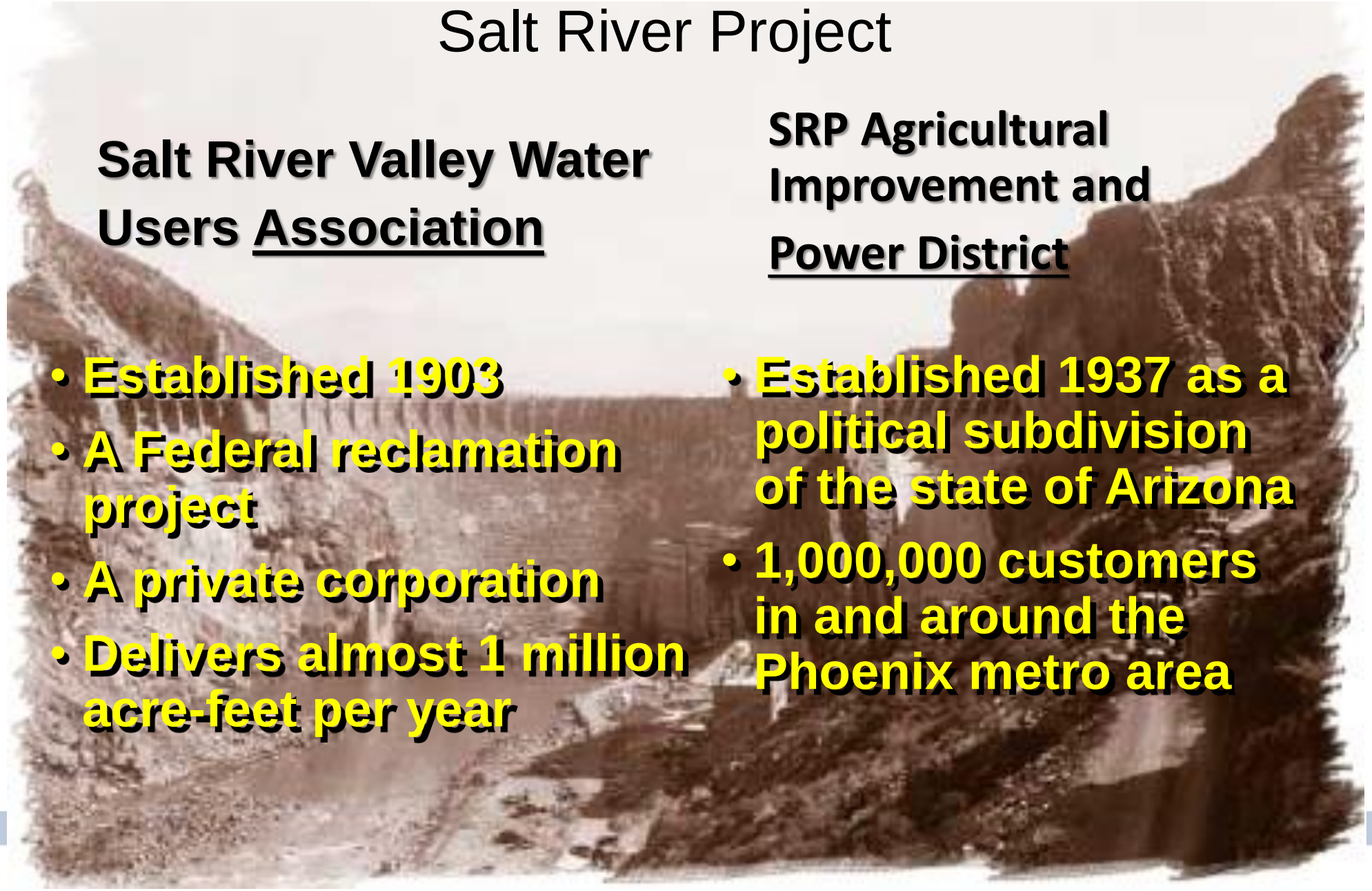
Outline


• SRP and the Reservoir System
• Hydro-climatology of the Watershed
• Recent Climate Change Projections
• Uncertainties

Salt River Project



Salt River Valley Water Users Association

- Established 1903
- A Federal reclamation project
- A private corporation
- Delivers almost 1 million acre-feet per year

SRP Agricultural Improvement and Power District

- Established 1937 as a political subdivision of the state of Arizona
- 1,000,000 customers in and around the Phoenix metro area

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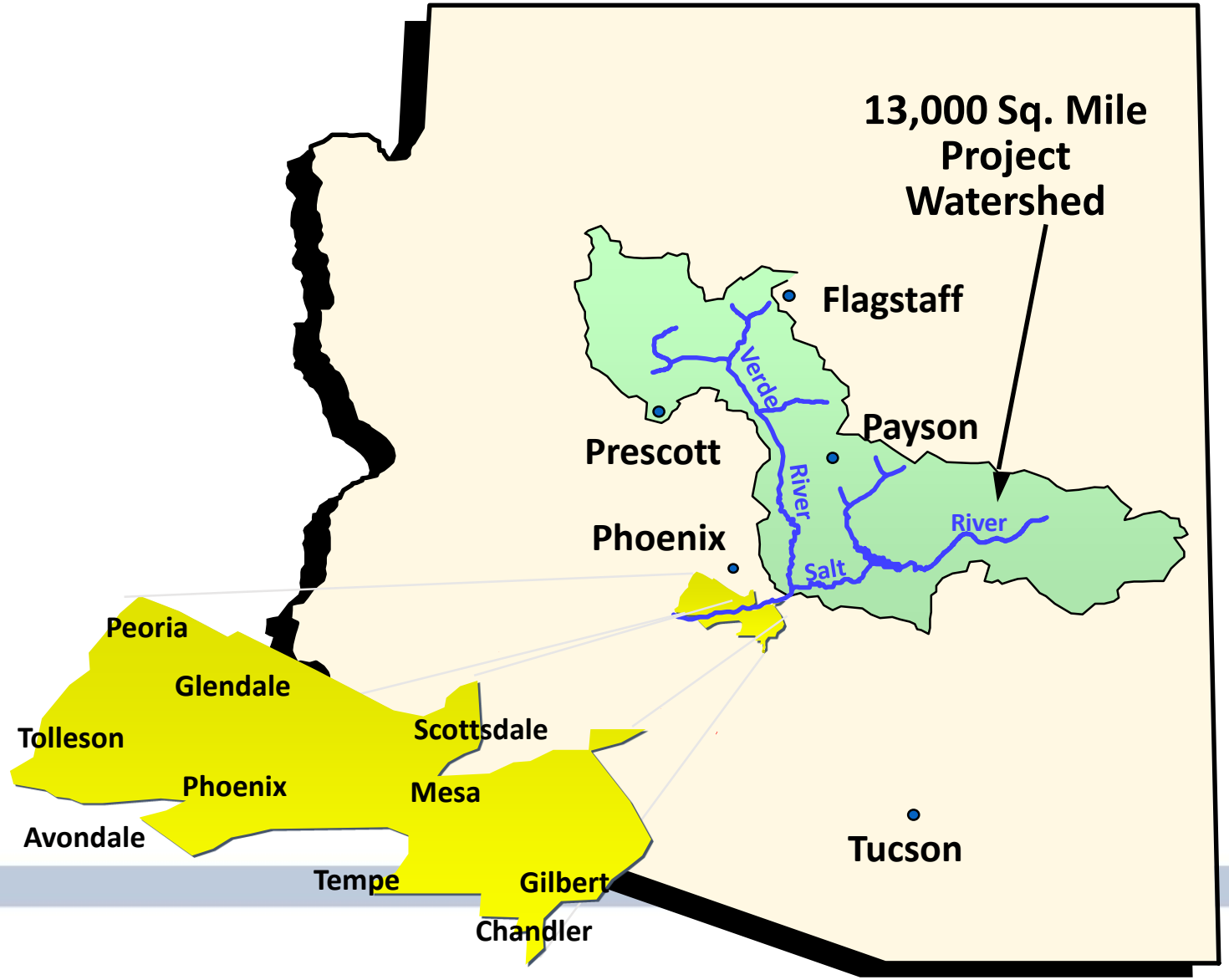
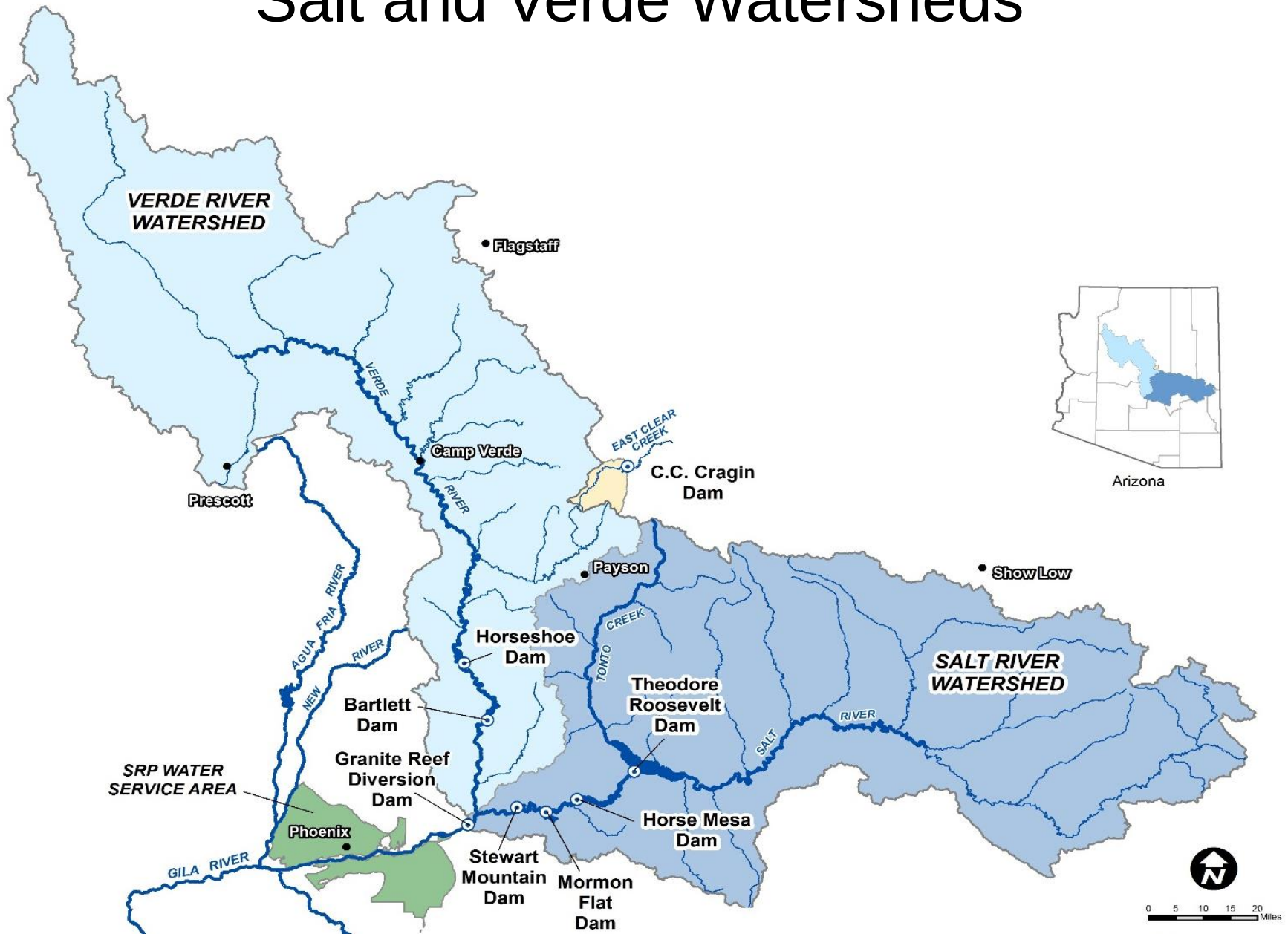
SRP's Water Service Area



Salt and Verde Watersheds



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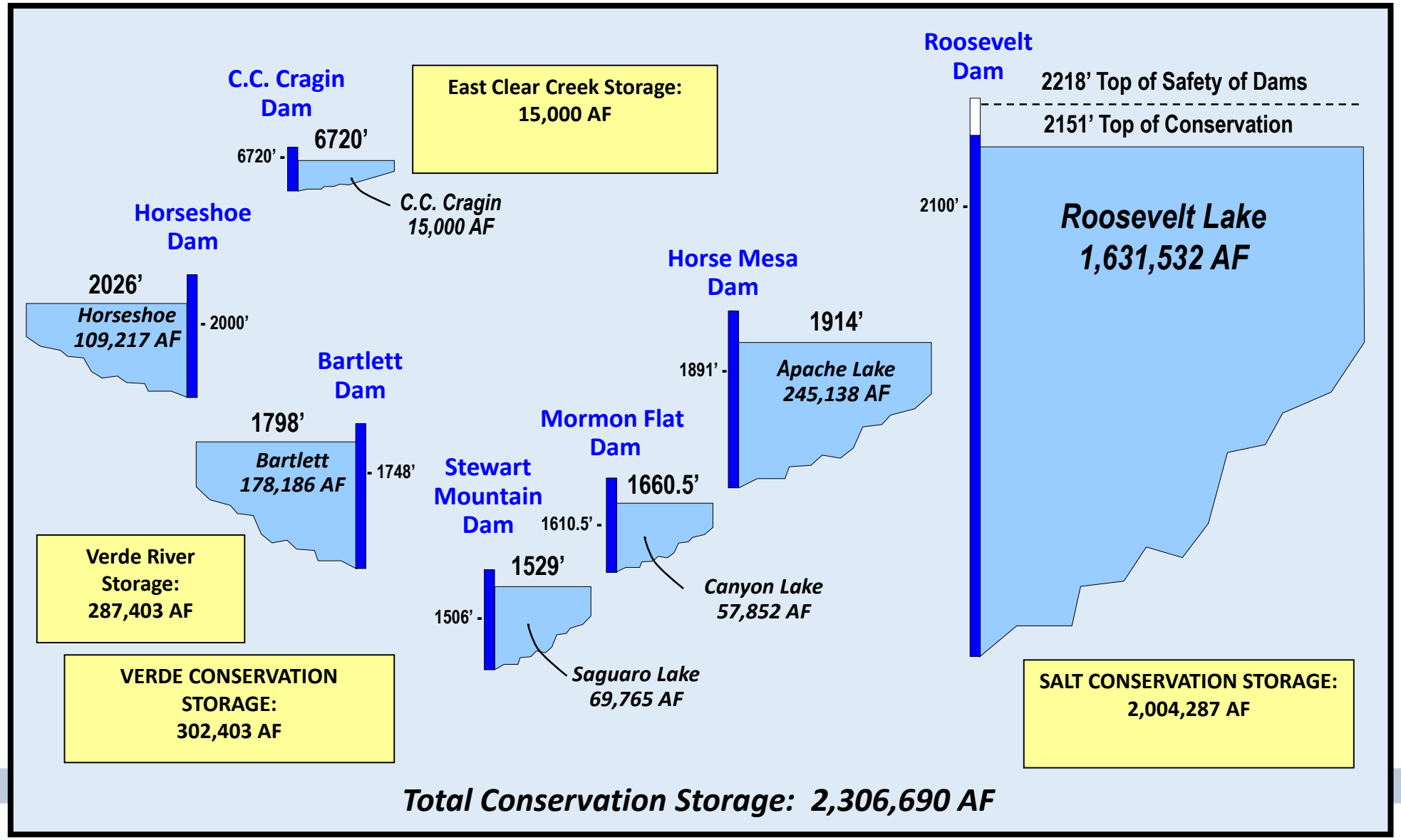
SRP's Reservoirs



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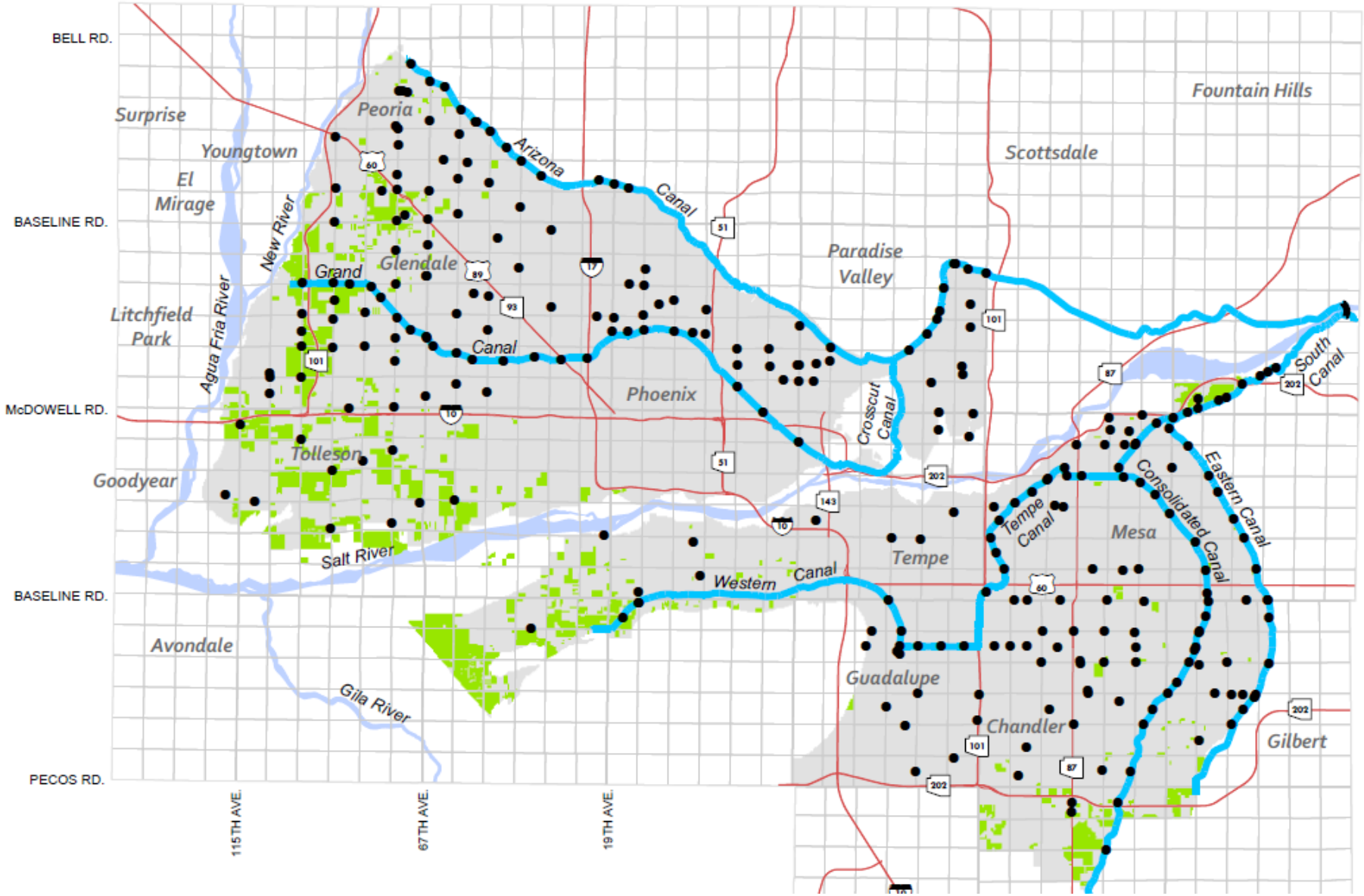
SRP's Delivery System



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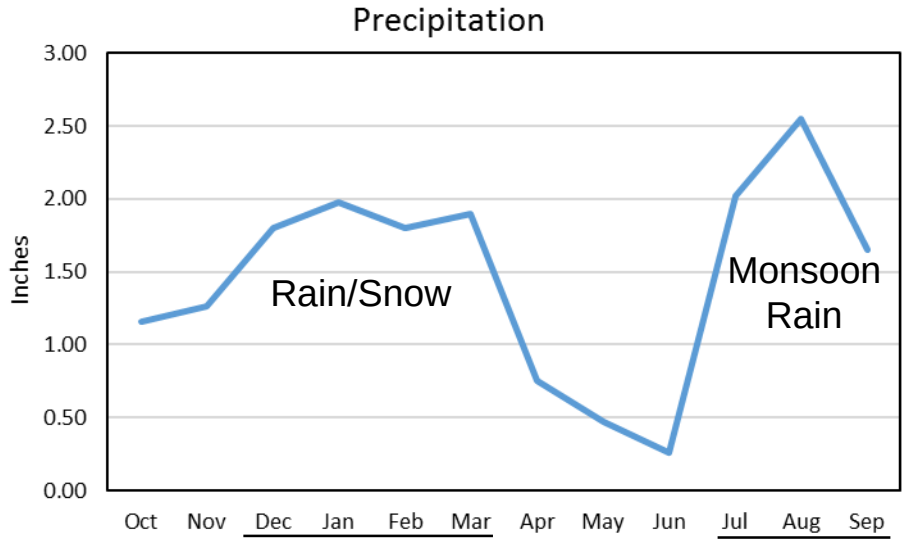
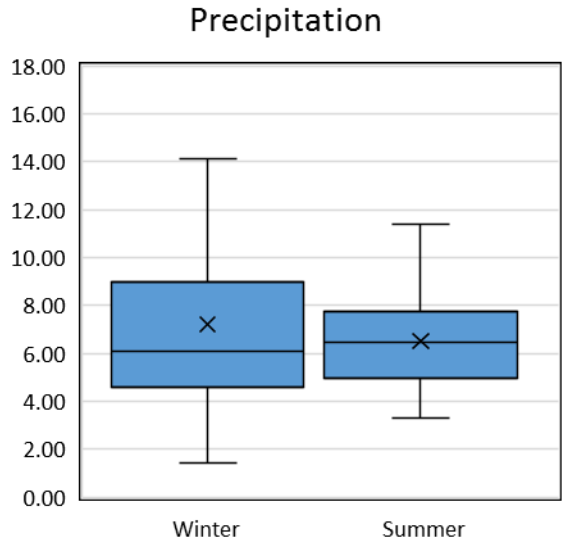
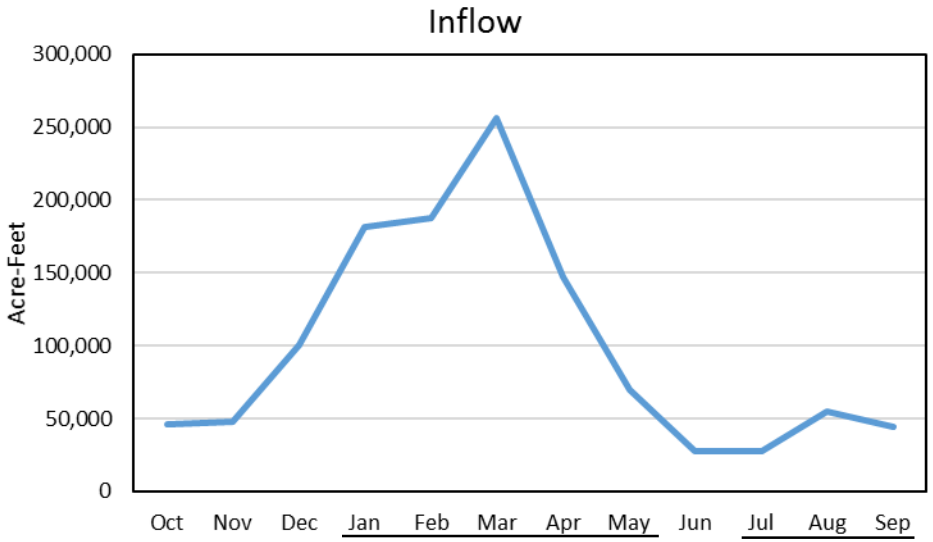
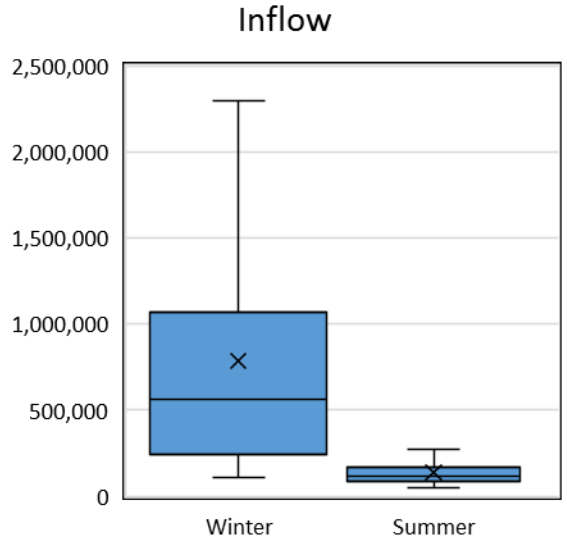
Salt and Verde Normals (1981-2010)









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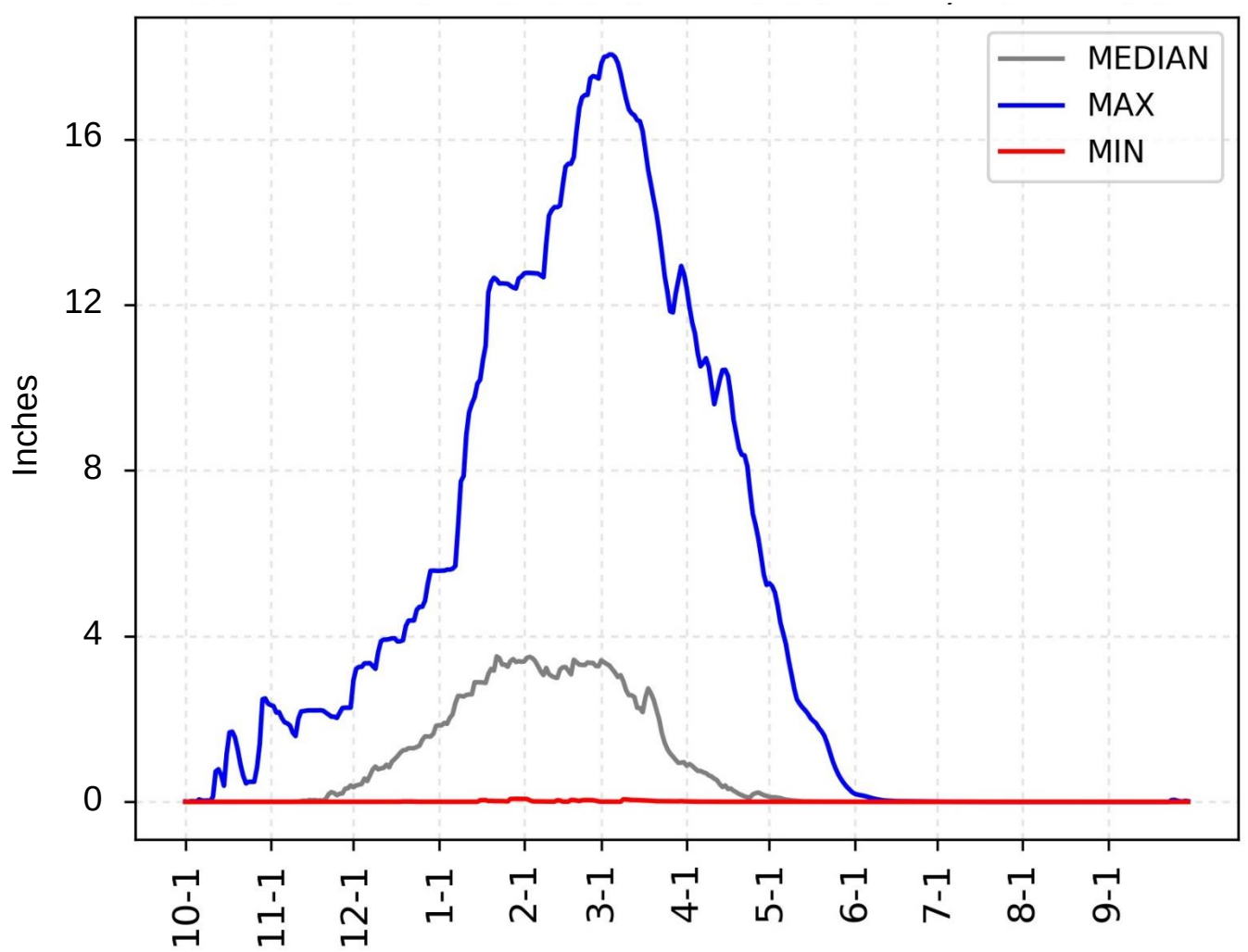
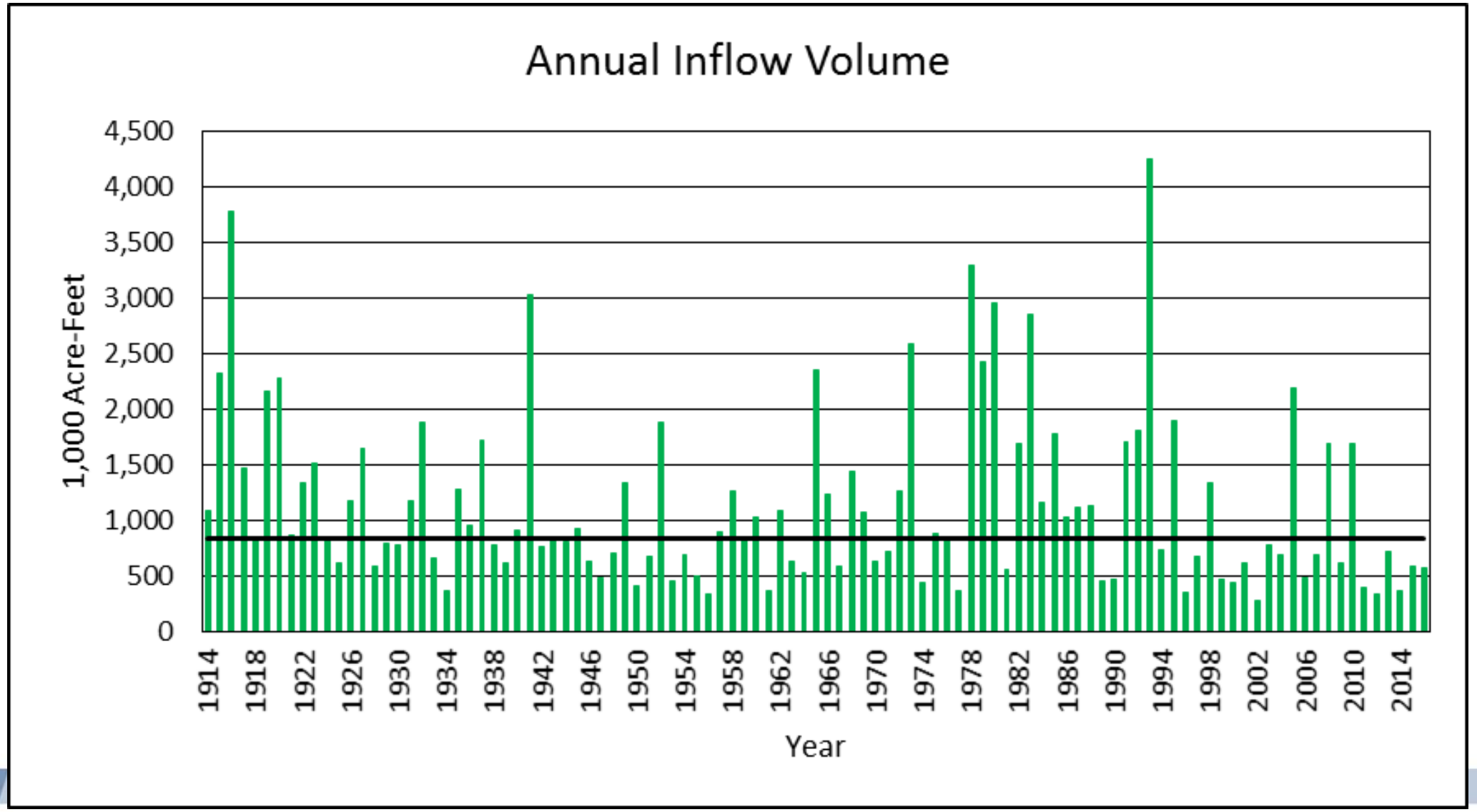
Climate Variability

Salt-Tonto-Verde SWE above 7,000’



Climate Variability



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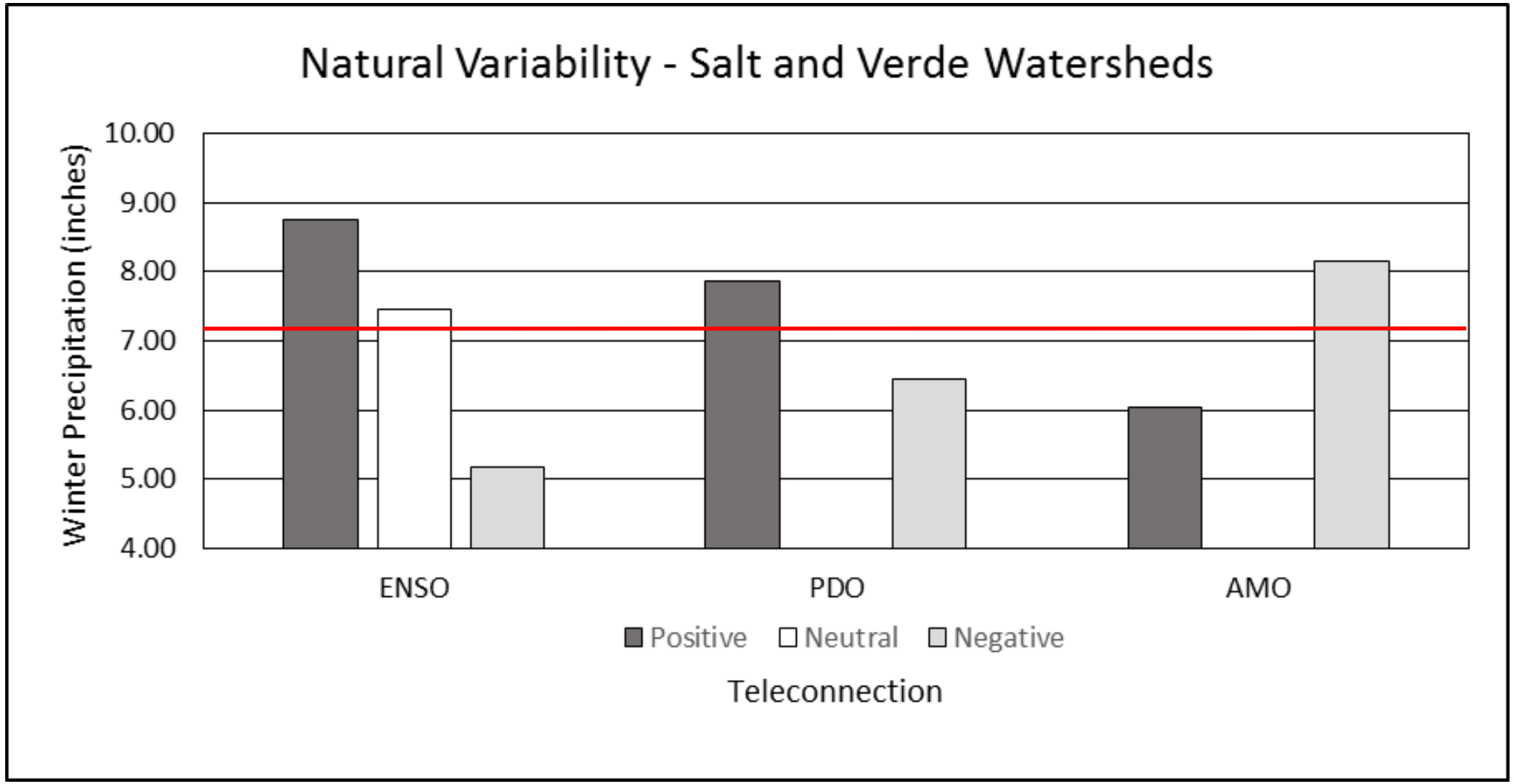
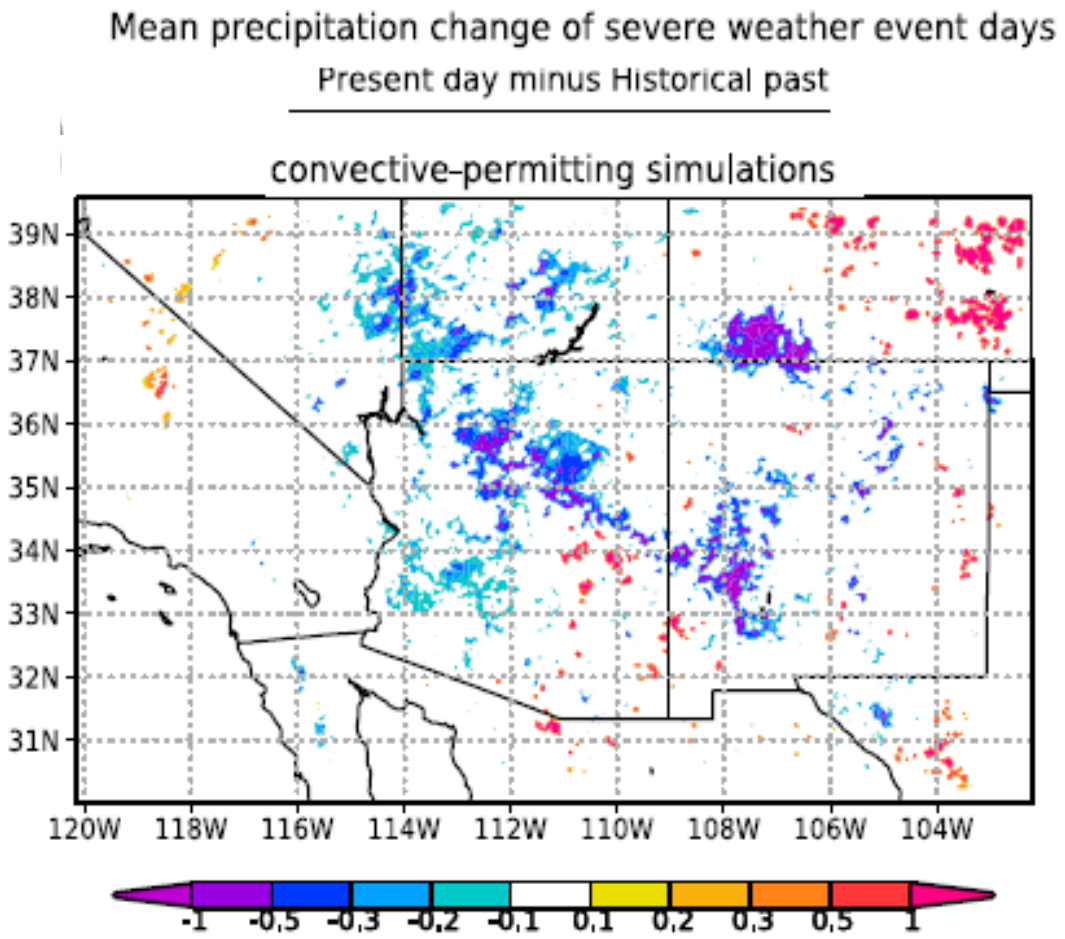
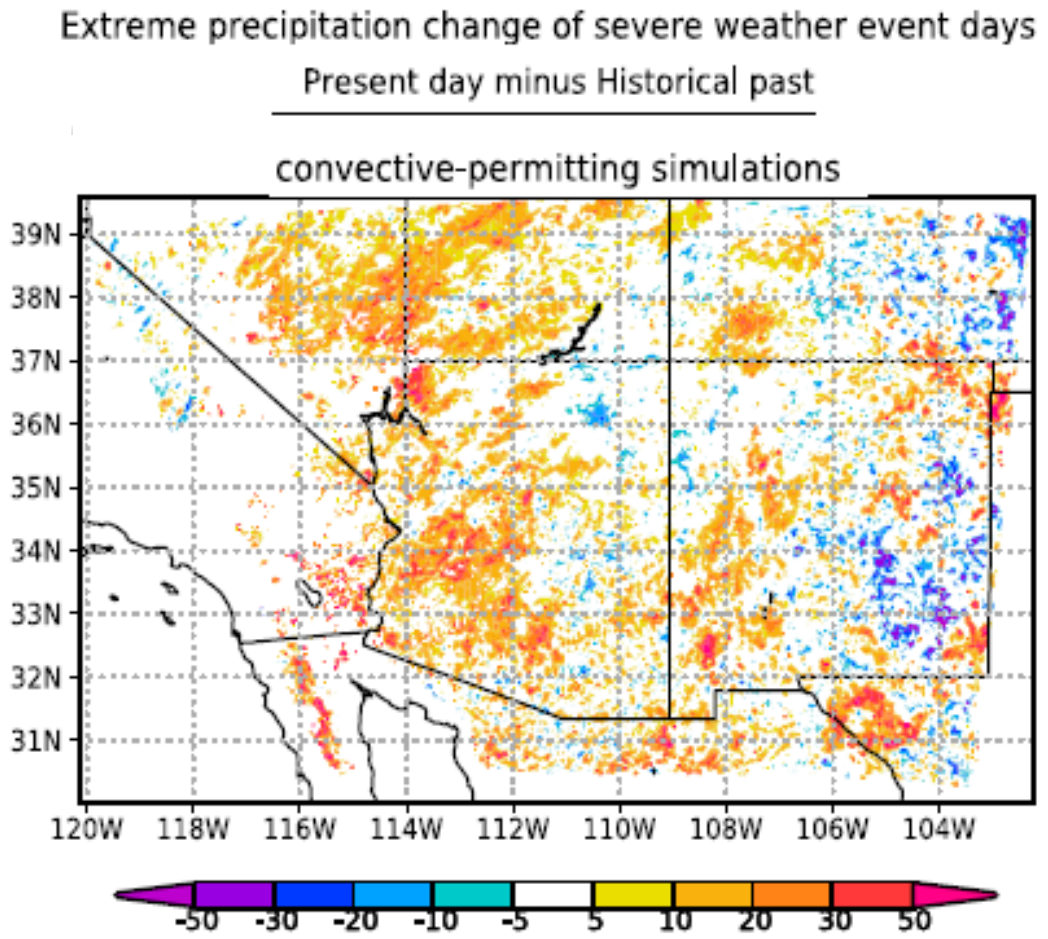
Climate Variability



Climate Change - Summer





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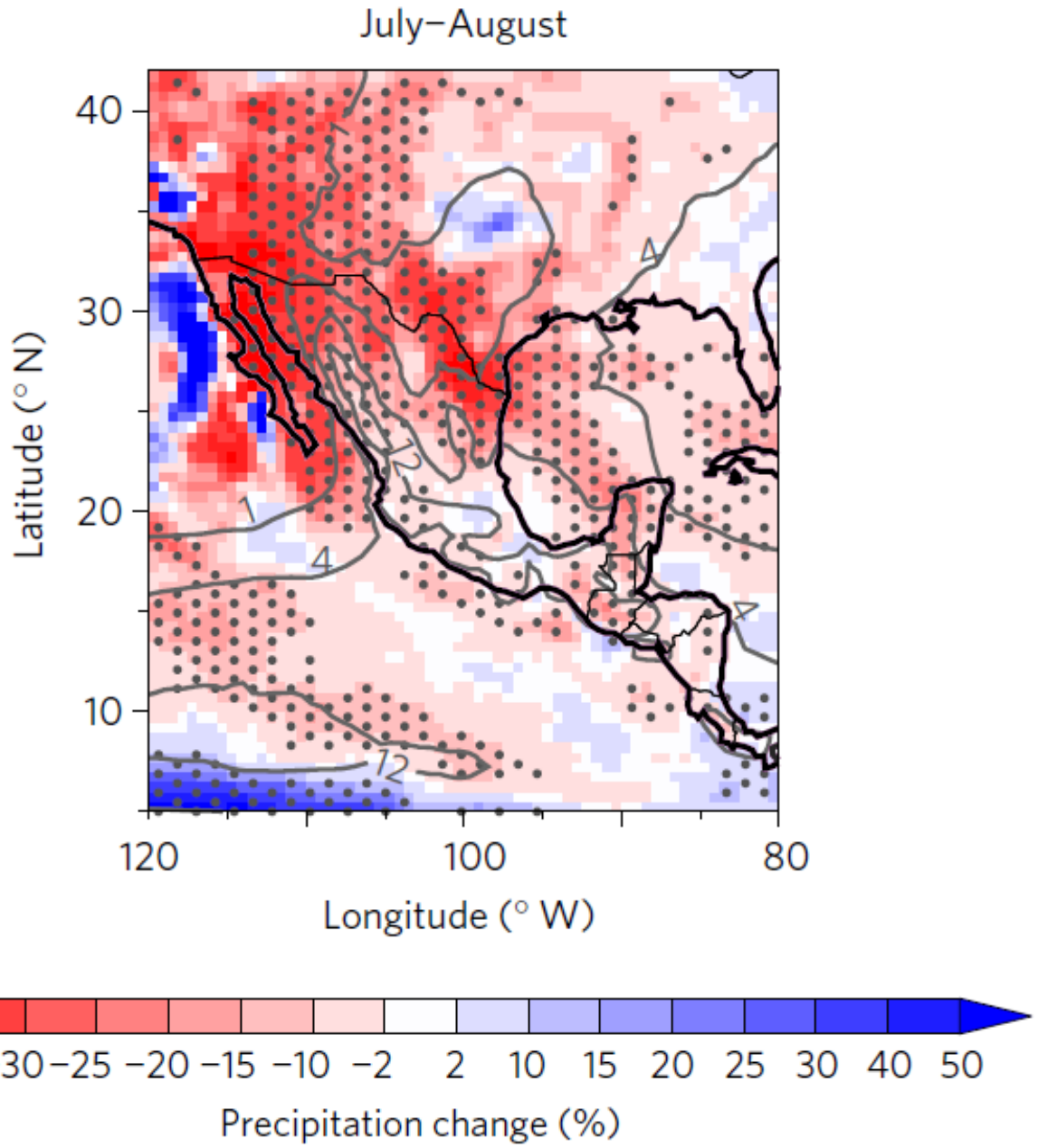
Luong et al. 2017

Climate Change - Summer



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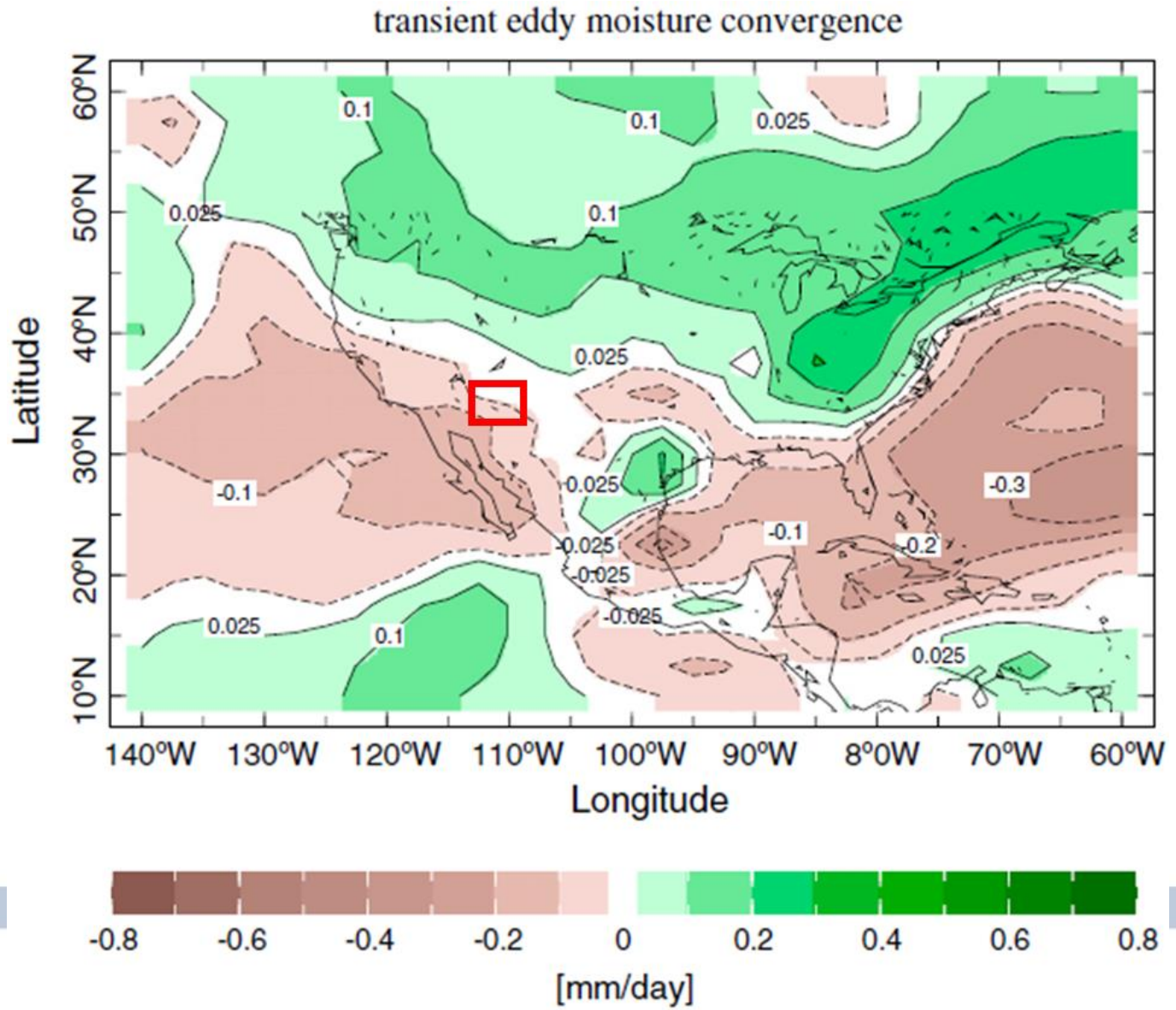
Pascale et al. 2017

Climate Change - Winter



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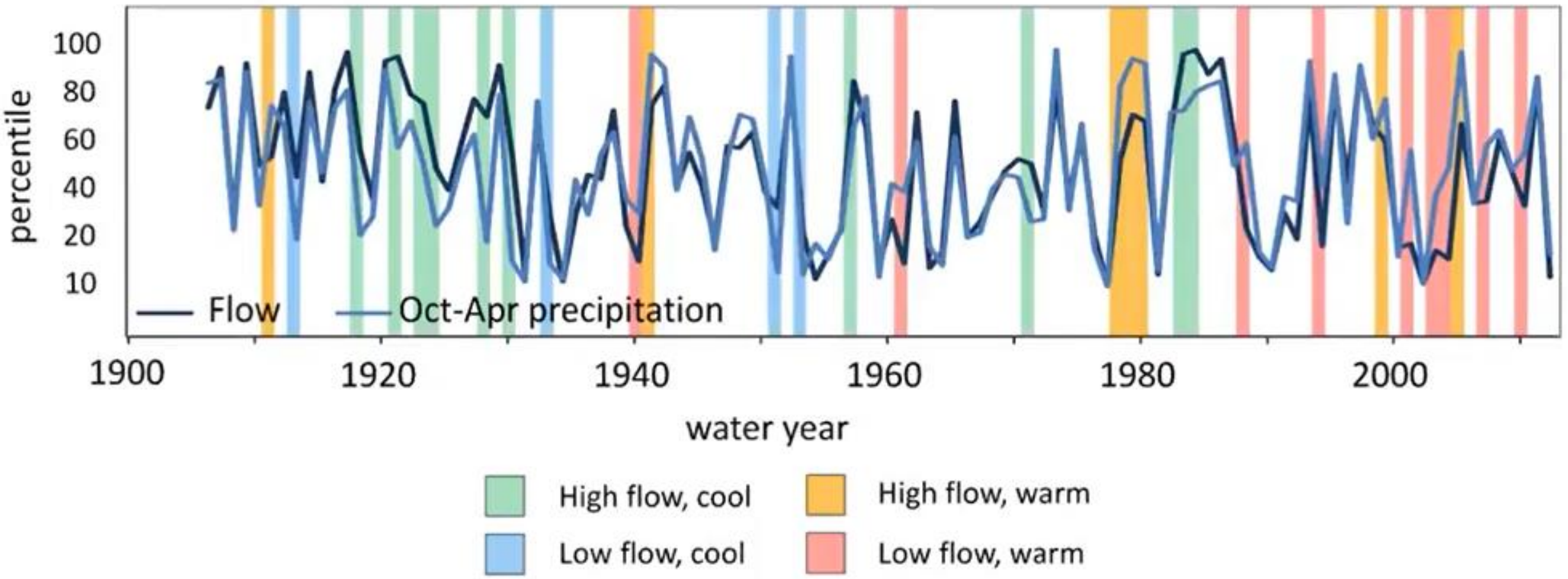
Seager and Vecchi 2010

Climate Change - Winter



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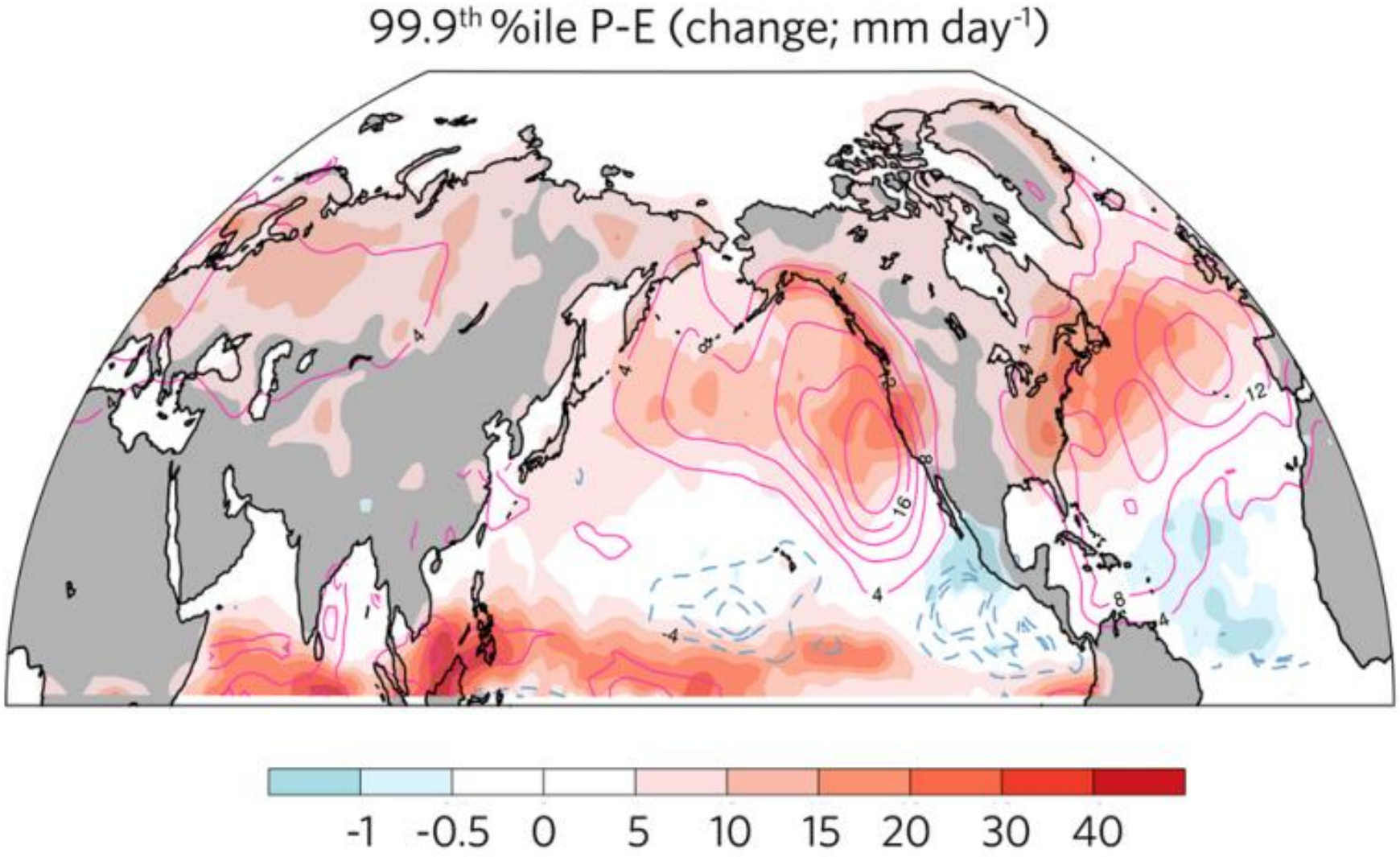
Woodhouse et al. 2016

Climate Change – Winter (AR's)



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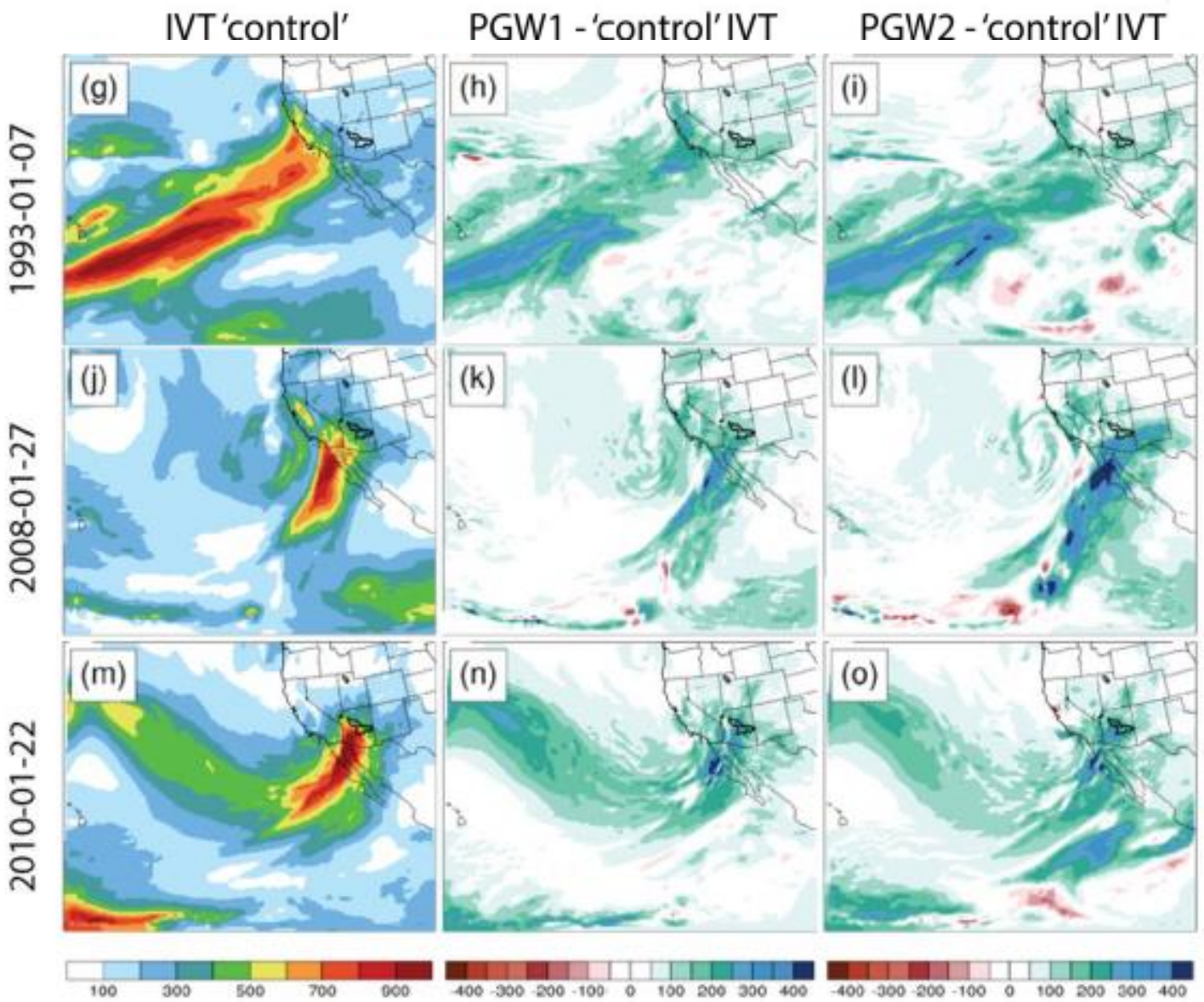
Lu et al 2018

Climate Change – Winter (AR's)



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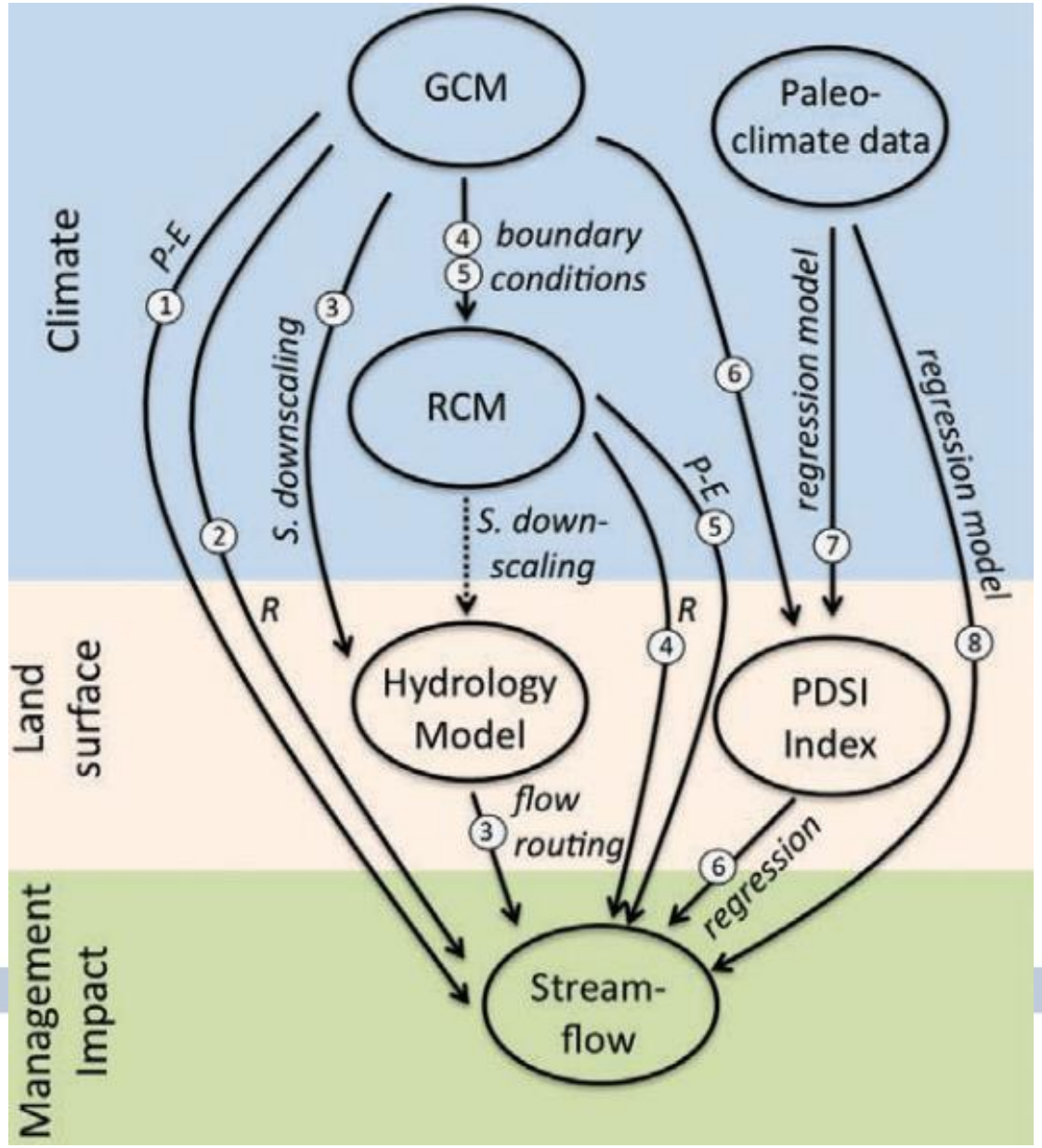
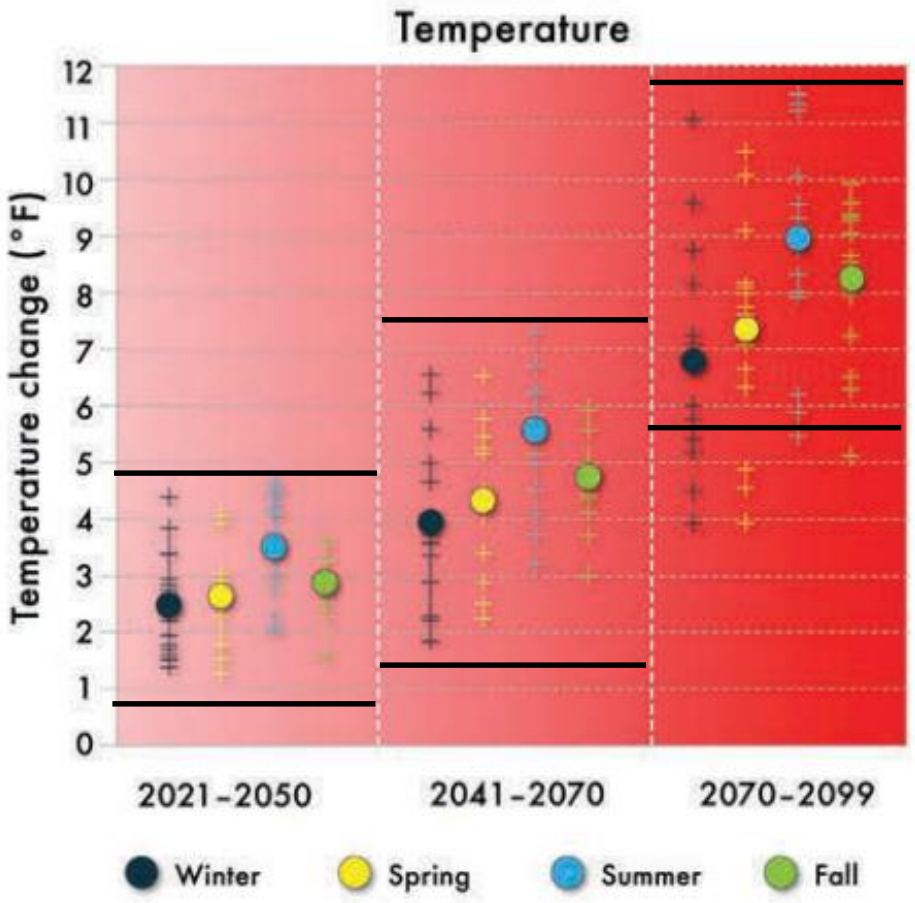
Singh et al. (in review)

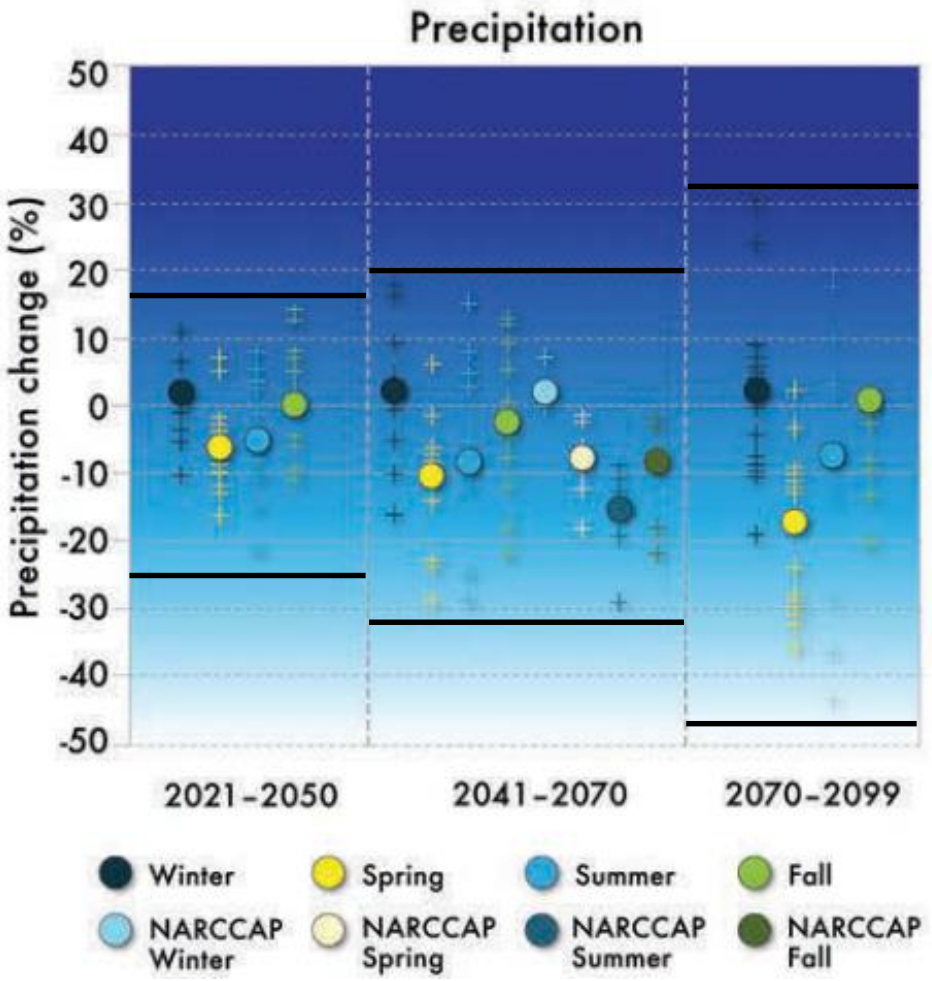
Climate Change – Uncertainties

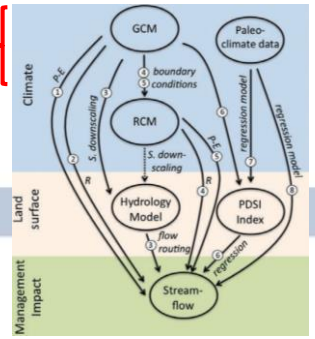


Vano et al. 2014

Climate Change – Uncertainties







Mearns et al. 2009

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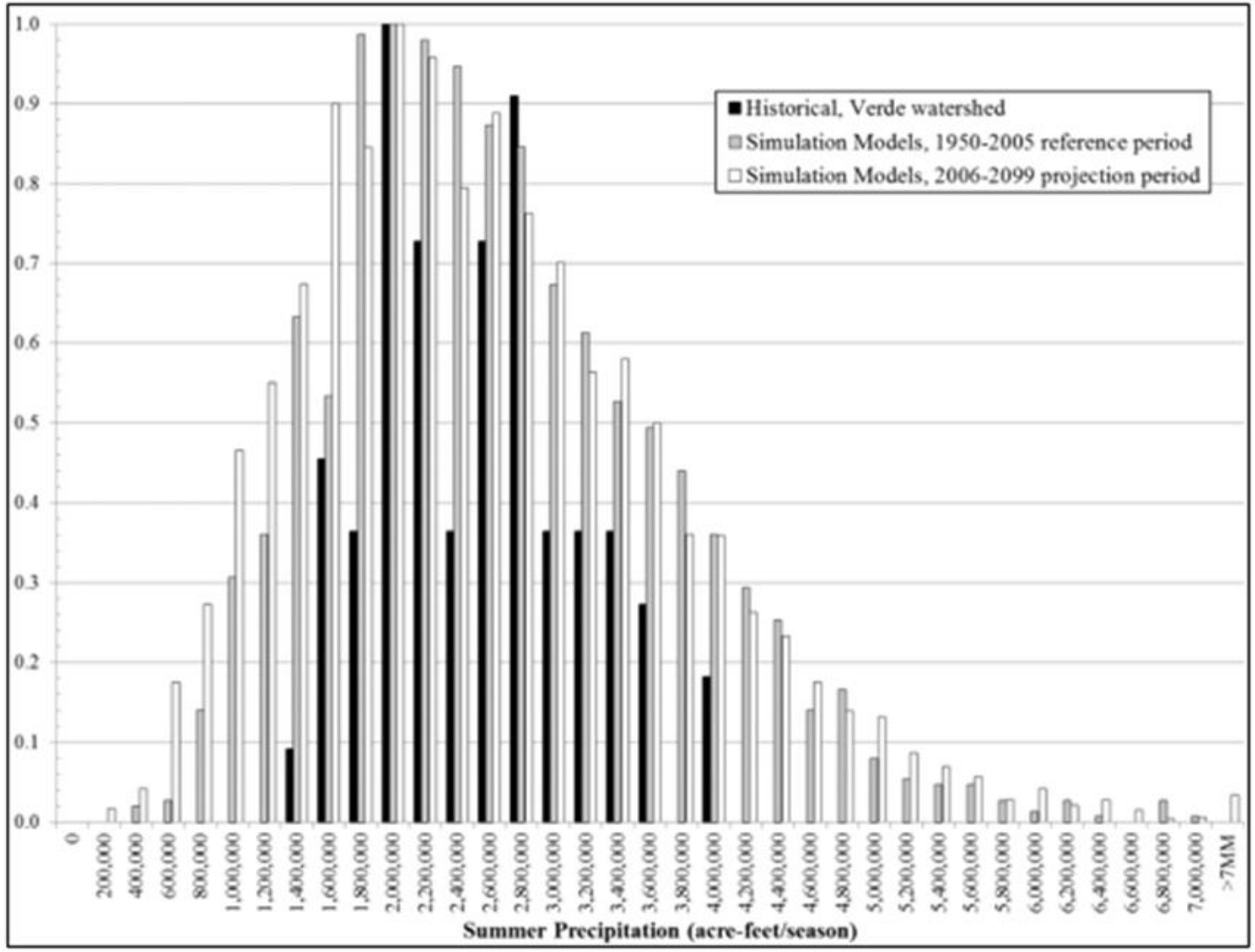
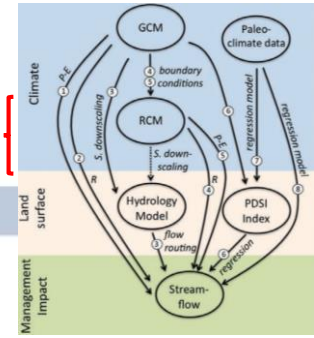
Climate Change – Uncertainties





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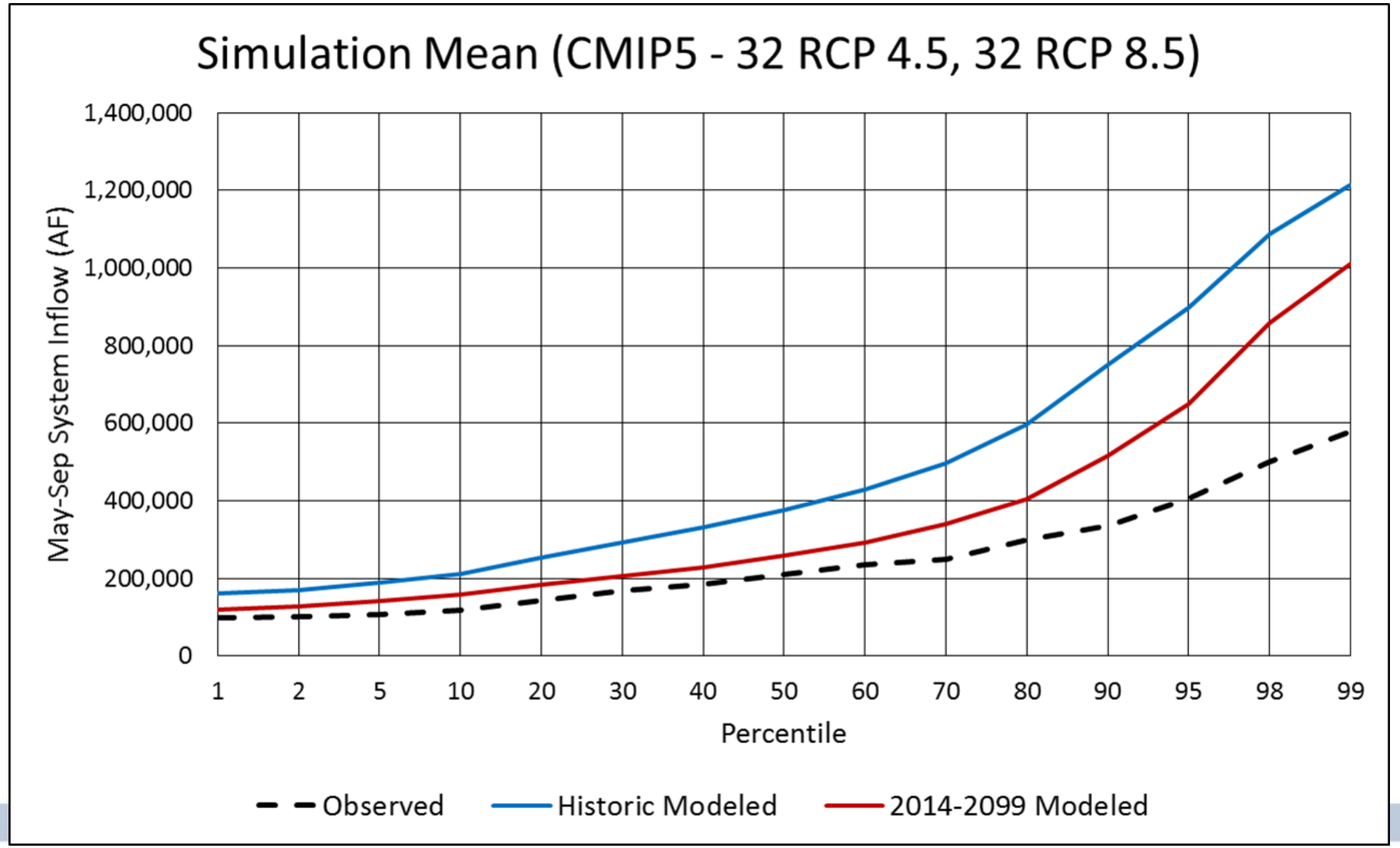
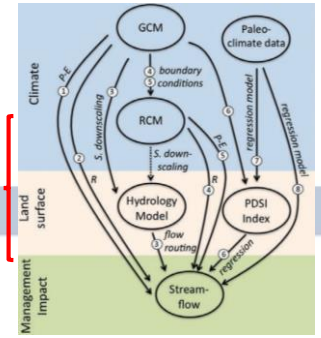
Climate Change – Uncertainties





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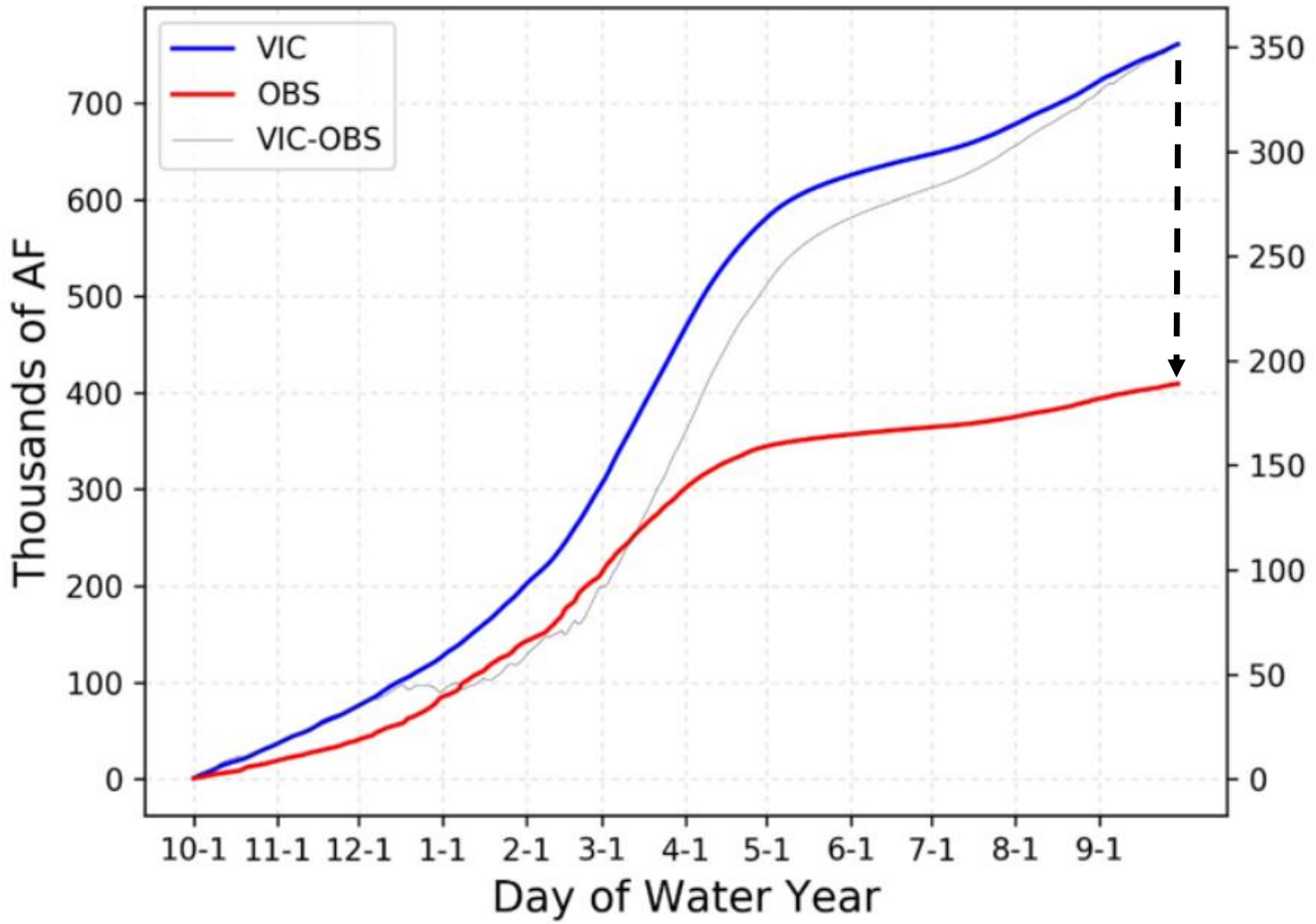
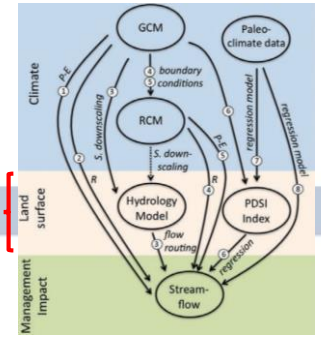
Climate Change – Uncertainties

Verde River Mean Accumulating Daily Inflow





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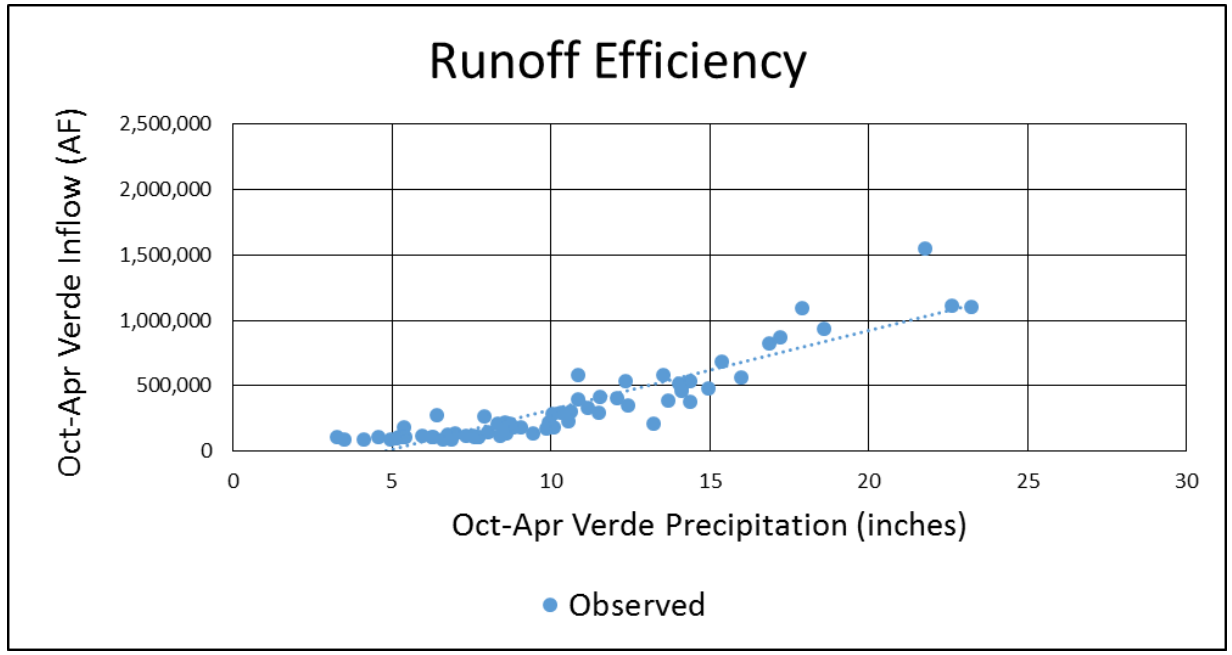
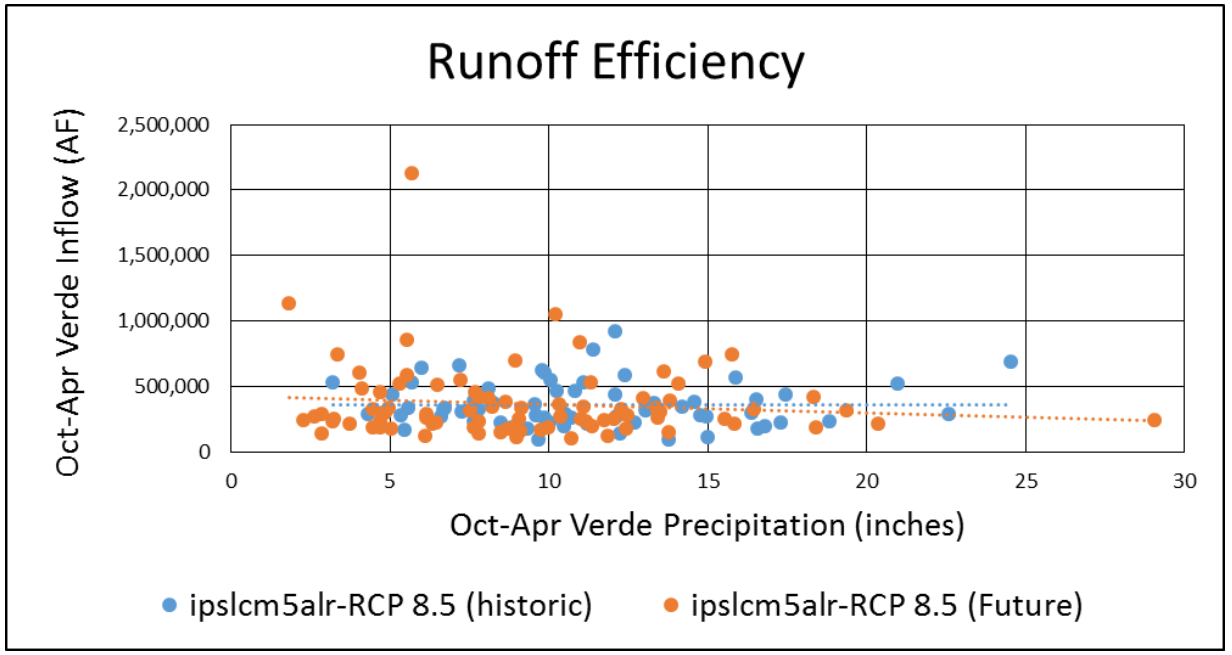
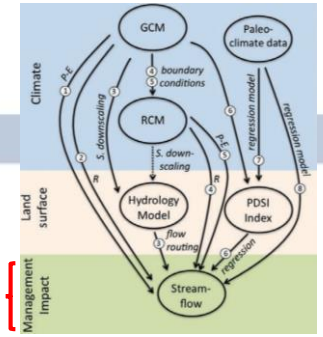
Climate Change – Uncertainties





	Oct-Apr Precipitation (inch)	Oct-Apr Inflow Volume (Kaf)
1981-2010 Obs Normals	**7.93**	**189**
1993 Obs	20.93	1,548
ipslcm5alr1rcp85 1957	22.58	294
2002 Obs	3.09	88
ipslcm5alr1rcp85 1964	3.21	529



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Questions

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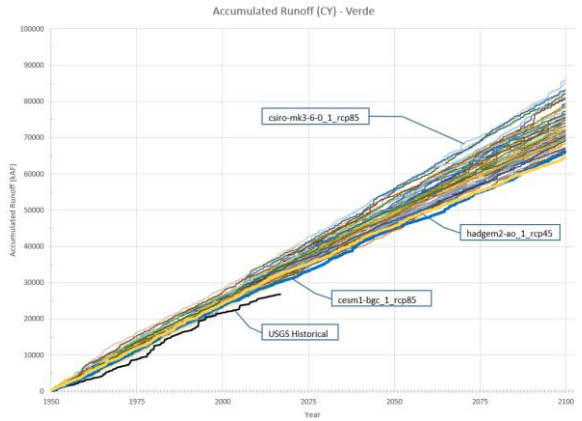
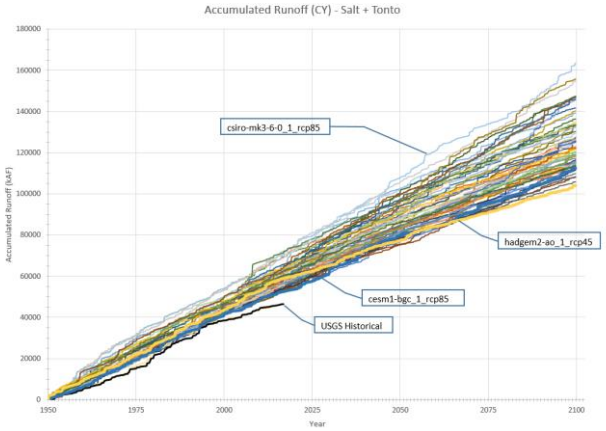
Streamflow Projection





SRP

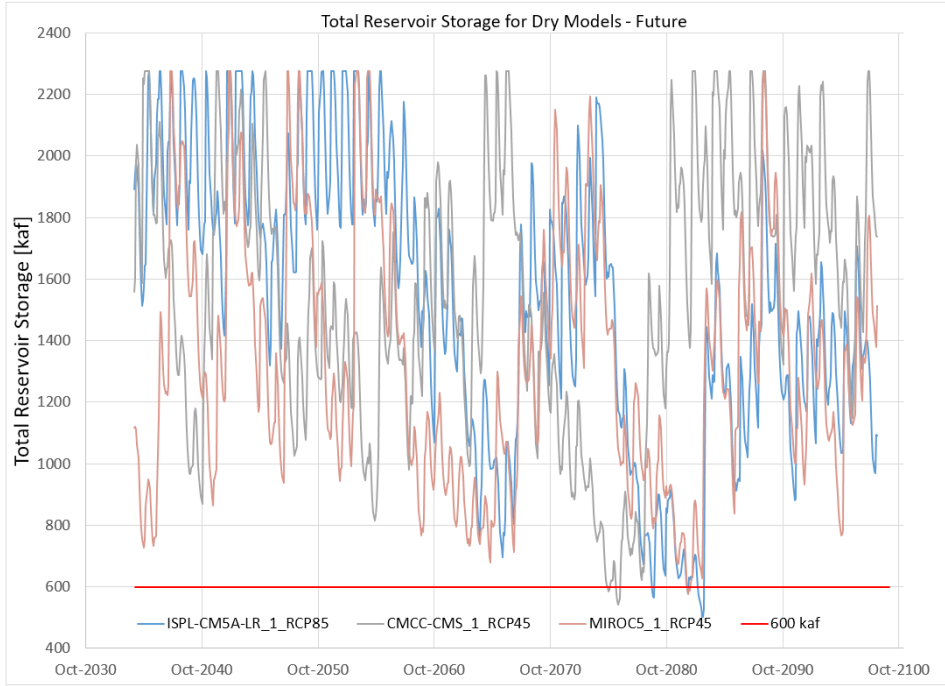
Reservoir Planning Model

an application of OASIS

Addendum to the
User Manual for OASIS with OCL™

April 2016

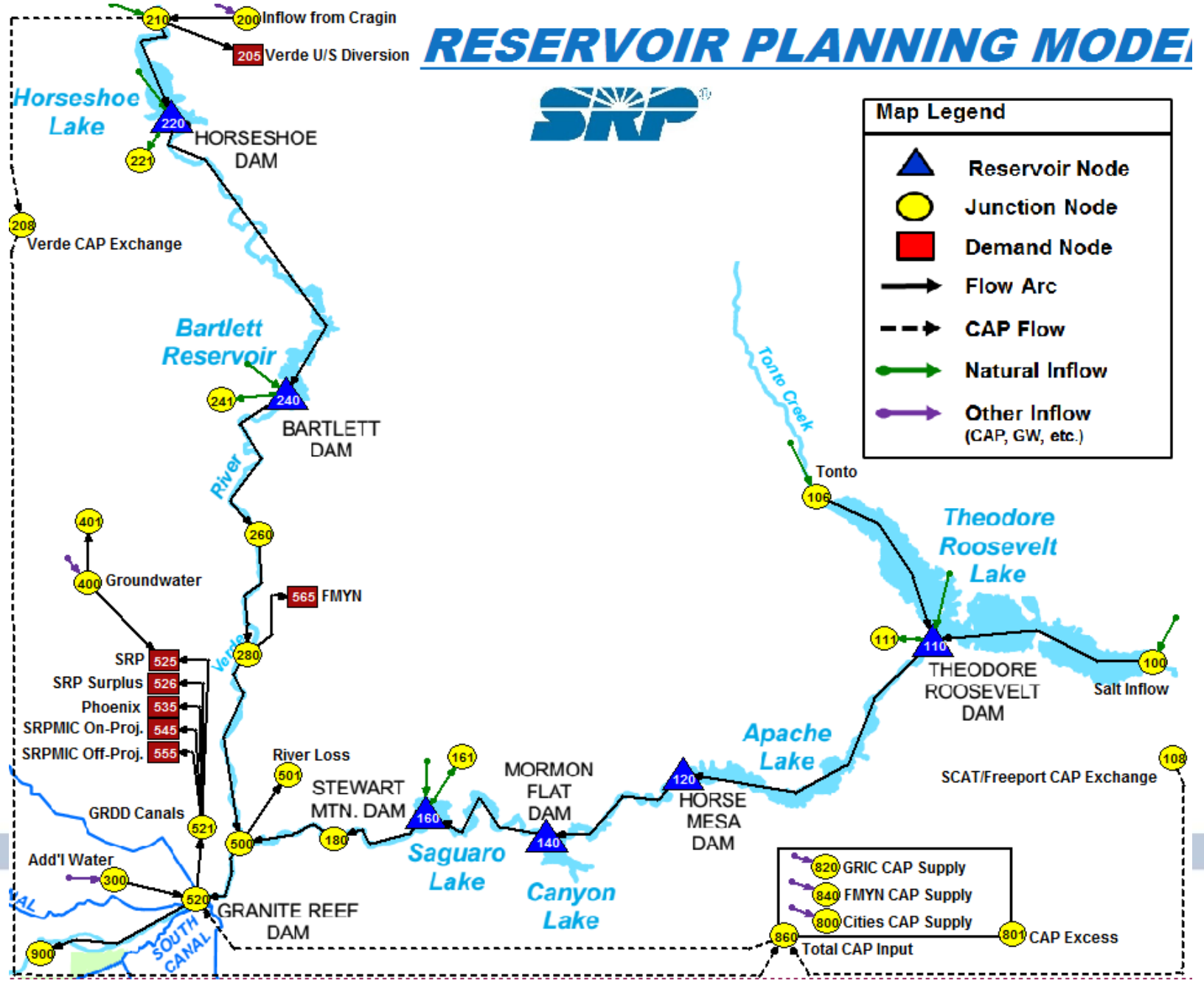
HYDROLOGICS
Advancing the management of water resources



System Health

RPM

- Inflow
  - Local (ungauged inflow)
- Reservoir Operations
- Deliveries
- Groundwater
- Reservoir/River Losses



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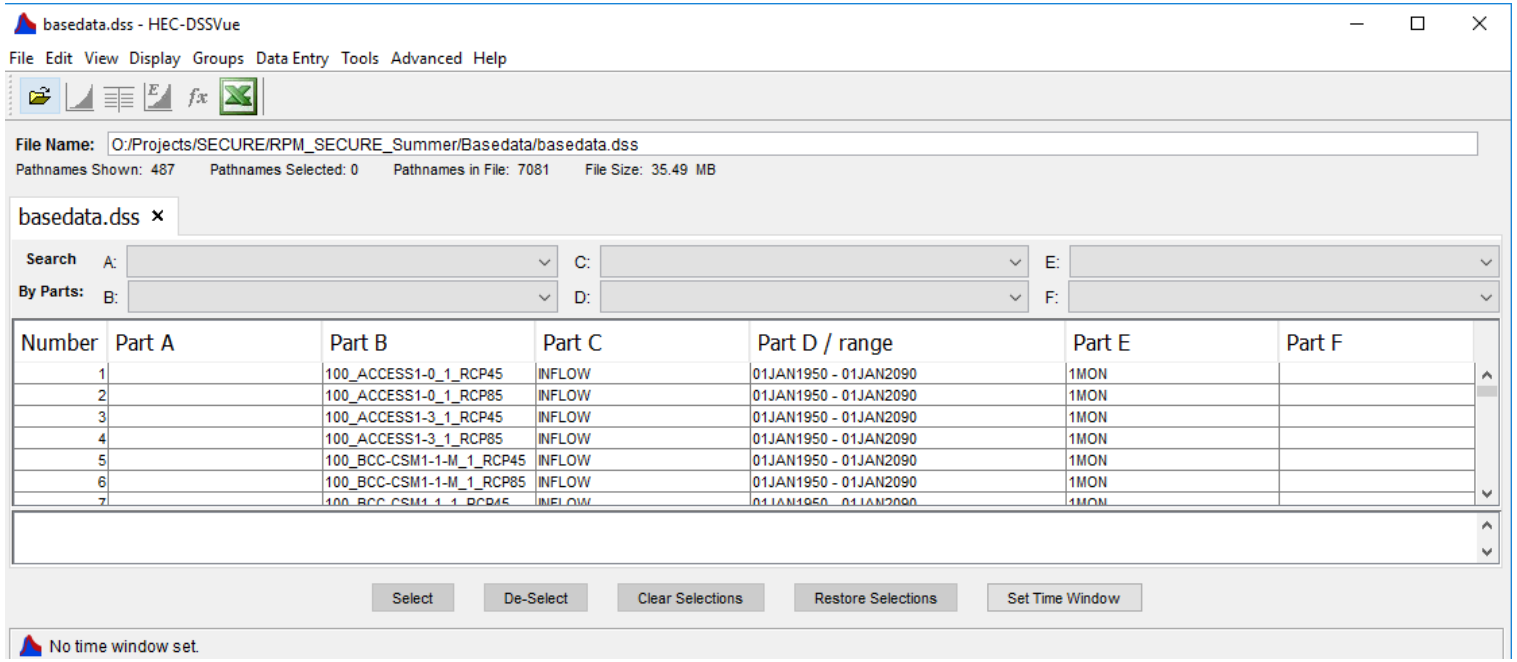
Running the RPM

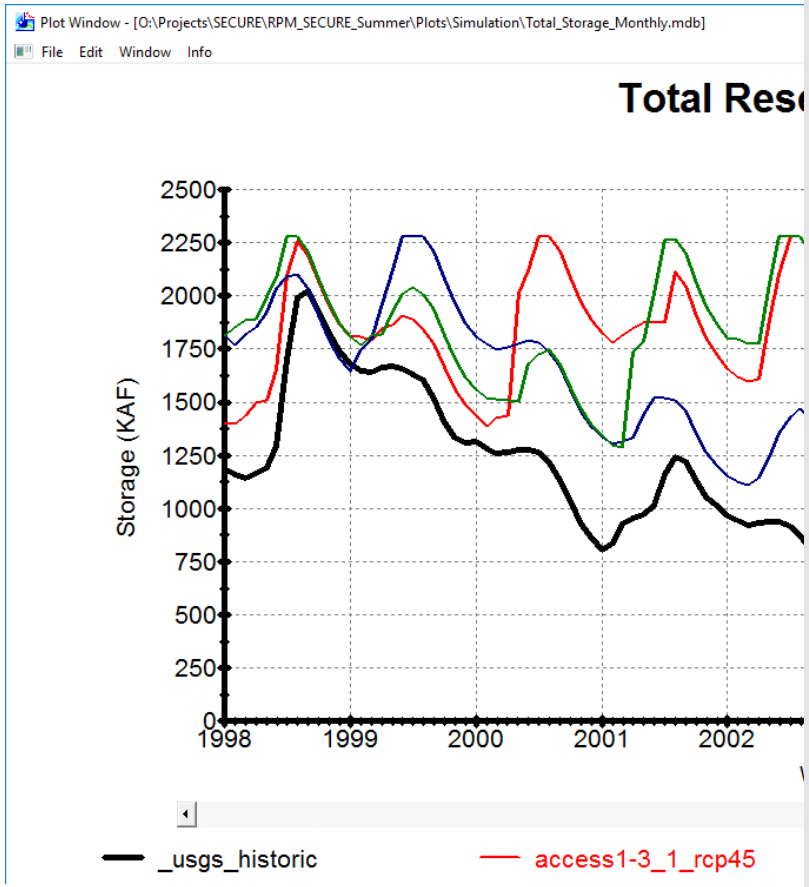
- Monthly time-step
- Can run through GUI
- Batch run
  - SRP Python script used to batch inflows into dss
  - Hydrologics executable for batch run
- 64 runs takes less than 10 minutes



RPM Output

- Detailed output for storage, demands, deliveries, exchanges, losses, spills, etc.
- Variety of standard reports and graphs
- Ad hoc reports and graphs
- Calculates various statistics about output data

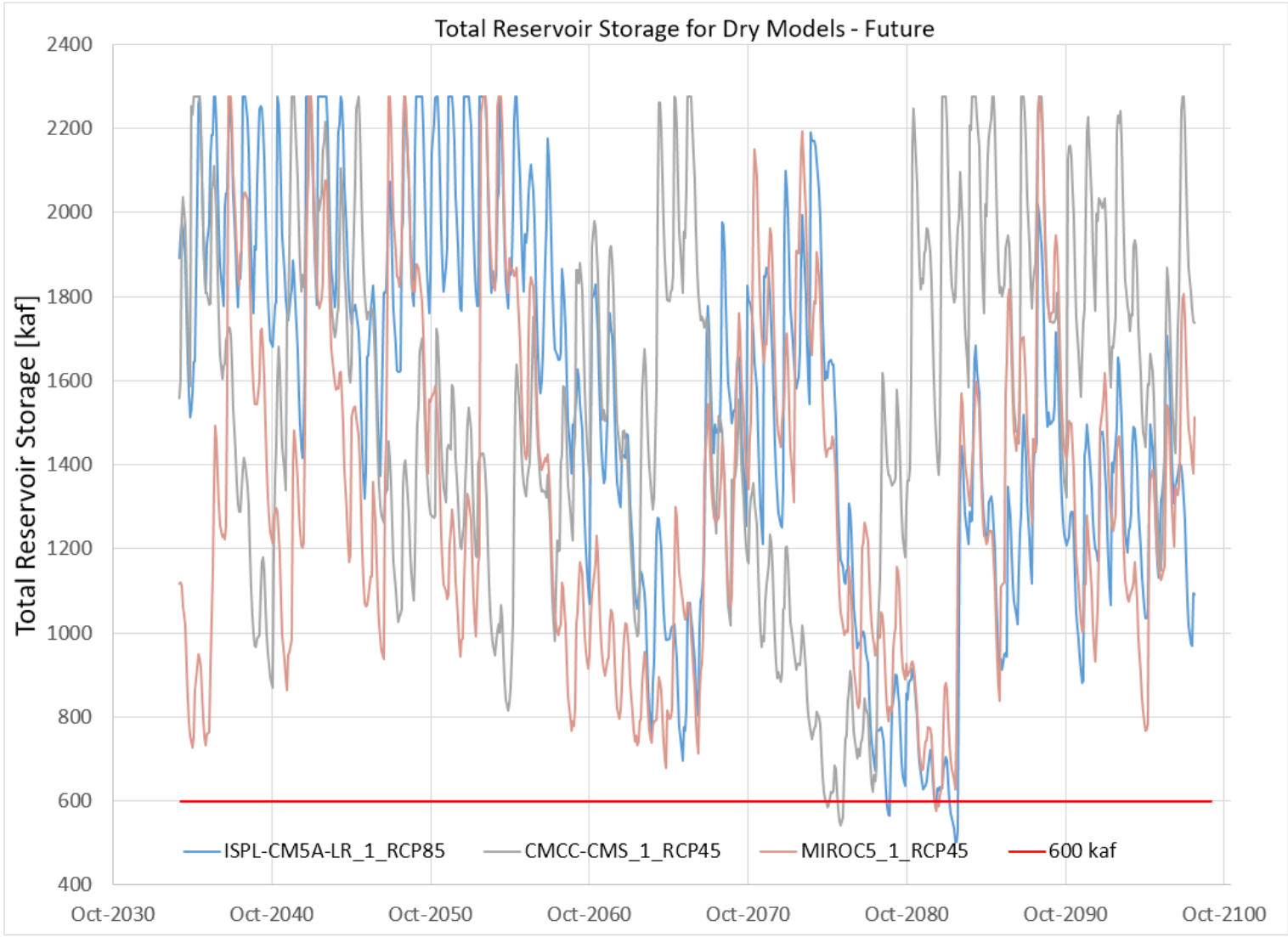
Examples of RPM Output



DATE	Verde Tangle KAF	Salt-Roos +Tonto KAF	V T+ST +Tonto KAF	Salt Spill KAF	Verde Spill KAF	Total Spill KAF	Total Demand KAF	SRP Demand KAF	Total Delivery KAF	Groundwat Pump KAF
1914	395	459	925	0	0	0	835	700	814	190
1915	871	1593	2653	744	292	1036	866	746	978	98
1916	1277	2360	3850	2191	874	3066	866	730	970	65
1917	893	707	1710	421	341	762	866	730	995	65
1918	500	349	895	0	158	158	866	730	875	65
1919	542	879	1533	0	0	0	866	730	965	65
1920	1266	1621	3156	1716	876	2592	866	737	1002	65
1921	310	511	856	0	0	0	866	762	845	65
1922	783	529	1474	165	348	513	866	751	959	65
1923	537	492	1150	0	61	61	866	730	902	65
1924	548	770	1451	386	203	589	866	730	966	65
1925	264	291	591	0	0	0	835	736	814	65
1926	513	631	1300	0	0	0	866	773	850	65
1927	818	793	1777	269	341	610	866	730	978	65
1928	314	282	631	0	0	0	866	730	849	65
1929	390	408	862	0	0	0	866	746	845	65
1930	287	472	796	0	0	0	866	771	845	65
1931	403	547	1042	0	0	0	866	764	845	65
1932	835	1169	2229	636	427	1063	866	735	940	65
1933	220	426	693	0	0	0	866	731	845	65
1934	164	236	420	0	0	0	835	720	814	65
1935	506	748	1347	0	0	0	866	780	845	152
1936	287	637	979	0	0	0	866	766	845	88
1937	819	878	1872	465	420	885	866	730	940	65
1938	436	354	835	0	114	114	866	734	877	65
1939	275	346	656	0	0	0	835	720	814	65
1940	220	297	530	0	0	0	835	764	814	114
1941	1158	1925	3418	1113	558	1671	865	763	1000	76
1942	286	555	895	88	13	101	866	730	921	65
1943	286	528	881	0	0	0	866	731	852	65
1944	429	329	836	0	0	0	866	730	895	65
1945	394	490	957	0	0	0	866	731	845	65
1946	215	302	554	0	0	0	835	720	814	65
1947	197	284	528	0	0	0	835	764	814	91
1948	236	465	729	0	0	0	825	773	804	176
1949	497	714	1326	0	0	0	852	804	846	200
1950	238	195	460	0	0	0	821	795	800	98
1951	211	197	489	0	0	0	821	800	800	152
1952	623	1185	2033	170	52	222	860	782	978	175
1953	197	243	491	0	0	0	866	730	845	88
1954	292	349	681	0	0	0	835	720	814	91
1955	213	219	493	0	0	0	835	764	814	123

Purpose of the RPM

- Current and future shortages
- Average surface water supply
- Future groundwater supply
- Effect of physical changes to reservoirs (i.e. increased conservation storage)
- Effects of operational changes to reservoirs
- Changes in demands
- Changes in exchanges and transfers
- Sedimentation effects



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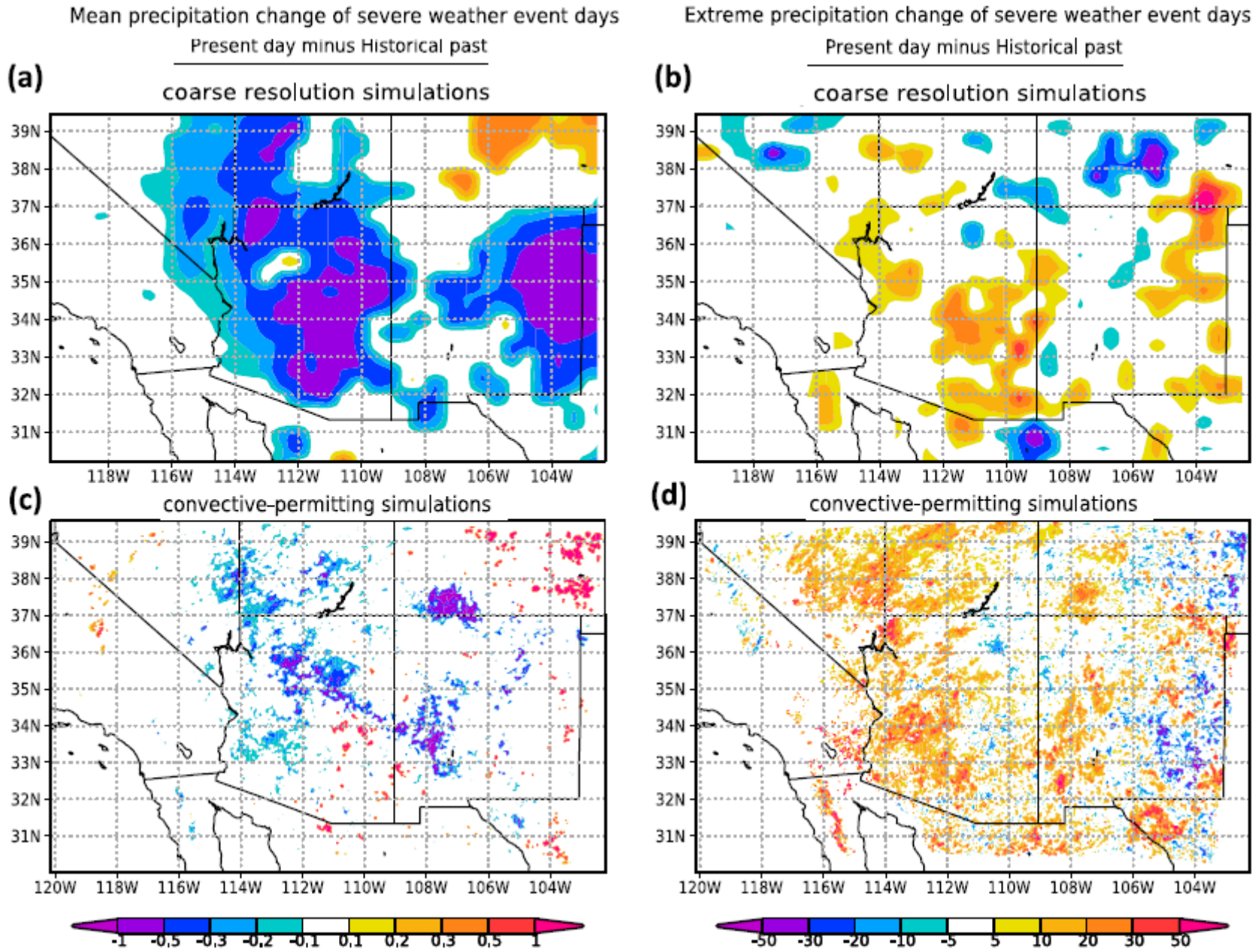
Benefits from high resolution dynamically downscaling



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