CLIMATE CHANGE IMPACTS ON SO-CAL WATER RESOURCES

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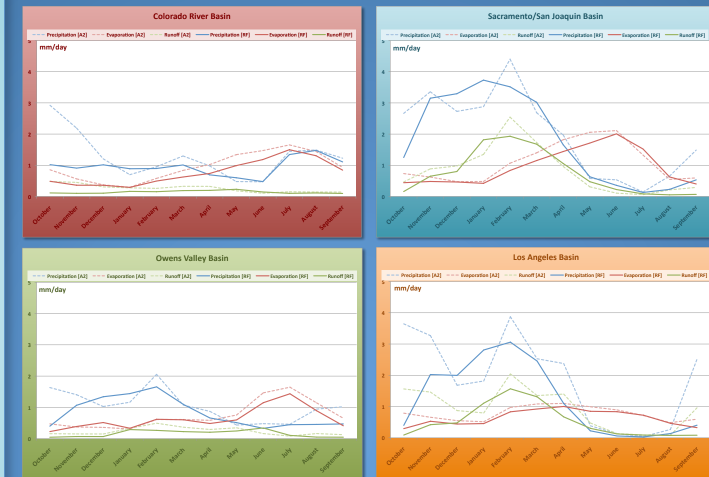
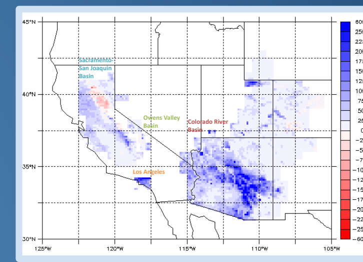
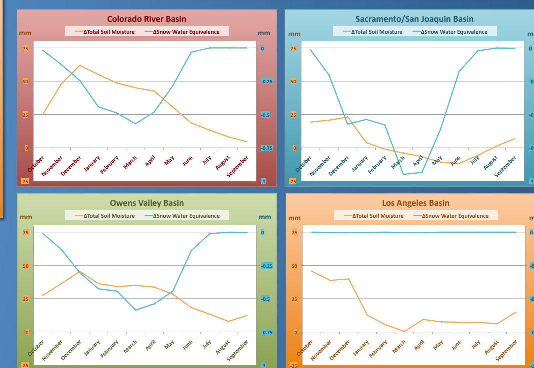
Temperature and precipitation are virtually certain to substantially change over the next century in response to anthropogenically enhanced greenhouse gas (GHG) forcing. Such changes will likely impact a wide variety of natural and human systems resulting in dramatic ecological, economic, and sociological consequences. Southern California, currently home to 22.4 million people, is heavily dependent on a water supply collected from several watersheds in the western United States, including the Colorado River, Owens Valley, and San Joaquin and Sacramento. In order to investigate the potential impacts of future climate change in response to anthropogenic GHG emissions, we analyze output from high-resolution nested climate model simulations of present climate (1961-1990) and projections of future climate (2071-2100) under the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES) A2 GHG emissions scenario. Compared to present day conditions, we find substantial modifications to the water budgets of many of the major river basins that supply water to Southern California. In particular, we see considerable increases in late-summer and early-fall precipitation and soil moisture, and decreases in snowmelt driven streamflow. In addition, at the seasonal time scale, in basins where a large fraction of the runoff comes from snowmelt, there is a shift to earlier runoff due to the less snow and earlier melting. These changes are likely to necessitate significant modifications to water resources and agriculture management strategies in Southern California, where little precipitation occurs during the summer season when water resources are in highest demand.

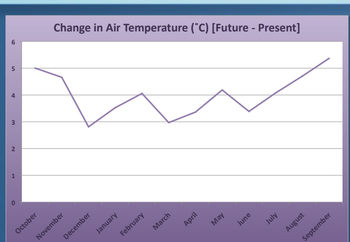


The graphs above chart the daily average precipitation, evaporation, and runoff of each month for each of the basins in both the RF (1960-1991) and A2 (2071-2100). The graphs to the right chart the difference between the average daily snow water equivalence and soil moisture of each month in the basin between RF and A2 time periods.

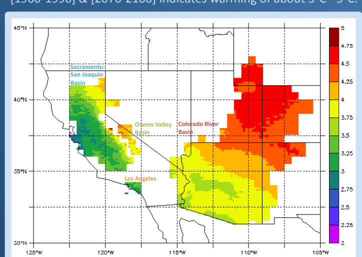
The map shows the change in average annual runoff between the RF (1960-1990) and A2 (2070-2100) models. It indicates higher amounts of runoff in all basins. This is supported by significant increases in precipitation and decreases in snowpack.







Simulated change in average air temperature between the time periods [1960-1990] & [2070-2100] indicates warming of about 3°C - 5°C.



Regional climate model output of the present climate (1960-1990) is compared to and to a plausible future climate scenario (2070-2010). The future scenario is based on the A2 IPCC SRES. This scenario most notably suggests a future of a divided world with independent nations, increasing population, and slow regional economic development. The analysis is applied to the watersheds providing Southern California's primary water supply: Colorado River, Owens Valley, San Joaquin and Sacramento Rivers, and Los Angeles.

	Colorado River			Sacramento/San Joaquin		
	REF	A2	Δ [A2-RF]	REF	A2	Δ [A2-RF]
Avg **Air Temperature (ºC)**	11.9	16.1	4.2	13.5	16.9	3.4
Annual Avg **Precipitation (mm/yr)**	348	467	119	654	733	79
Annual Avg **Evaporation (mm/yr)**	279	345	66	350	403	53
Annual Avg **Runoff (mm/yr)**	51	95	44	273	301	27
Avg **Snow Water Equivalence (mm)**	0.32	0.10	-0.22	0.47	0.09	-0.38
Avg **Soil Moisture (mm)**	228	261	33	293	295	3

	Owens Valley			Los Angeles		
	REF	A2	Δ [A2-RF]	REF	A2	Δ [A2-RF]
Avg **Air Temperature (ºC)**	9.0	13.1	4.0	17.4	20.7	3.2
Annual Avg **Precipitation (mm/yr)**	300	383	82	447	685	239
Annual Avg **Evaporation (mm/yr)**	233	273	40	233	284	51
Annual Avg **Runoff (mm/yr)**	59	86	27	192	341	149
Avg **Snow Water Equivalence (mm)**	0.72	0.32	-0.40	0.00	0.00	0.00
Avg **Soil Moisture (mm)**	194	221	27	307	324	16

Averages of the temperature, precipitation, evaporation, runoff, snowmelt, and soil moisture values of the RF simulation (1960-1990) and A2 simulation (2070-2100).

Analysis of the simulations indicates a warmer, wetter future in all of these watersheds. There are substantial increases in precipitation, particularly in early fall. However, there is considerably less snowpack, which is the primary means of natural storage and natural flow regulation in the basins. This accounts for increases in earlier runoff. Soil is also depicted to retain higher amounts of moisture. In terms of agriculture, this can result in increased productivity. In addition, this additional water could potentially meet the increased water demands resulting from the large population increases projected for Southern California. On the other hand, the increased precipitation and the shift from snowmelt driven runoff to rainfall driven runoff would likely lead to the increased occurrence flooding and resulting damage. As a result, improved water resources management practices and flood control mechanisms should be implemented such as increased reservoir capacity and additional reservoirs.