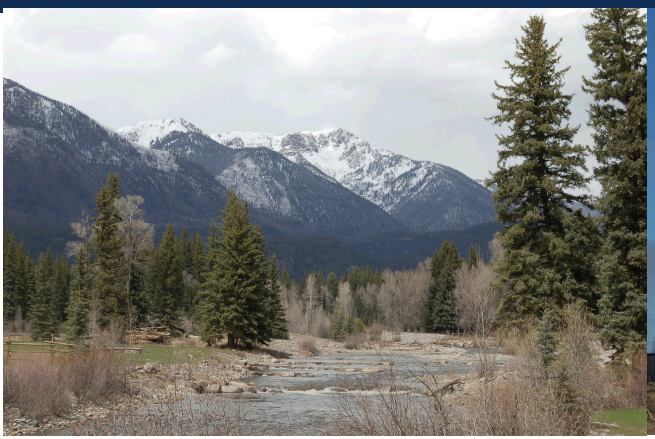
SAND2016-12527C



Energy-Water-Land-Climate Nexus: Modeling Impacts from the Asset to the Regional Scale

Vincent Tidwell, Alexis Corning-Padilla
Katrina Bennett, Richard Middleton
Susan Behery
Jordan Macknick, Greg Brinkman and Measrainsey Meng

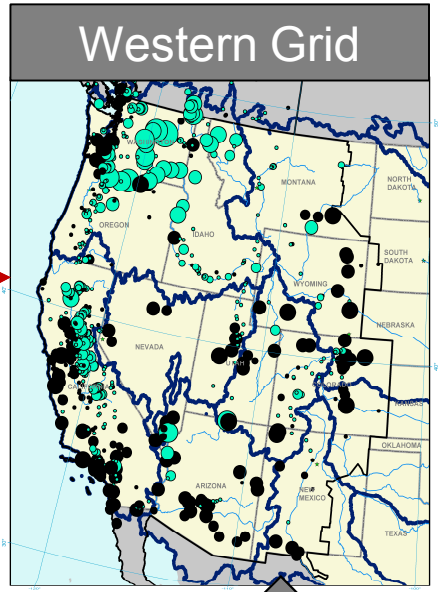
2016 Fall Meeting of the American Geophysical Union
San Francisco, December 14, 2016

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Objective

- Framework that links natural and engineered systems to evaluate climate vulnerabilities at the ***asset level***:
  - Multiple interacting sectors,
  - Multiple forcings, and
  - Multiple interacting scales.

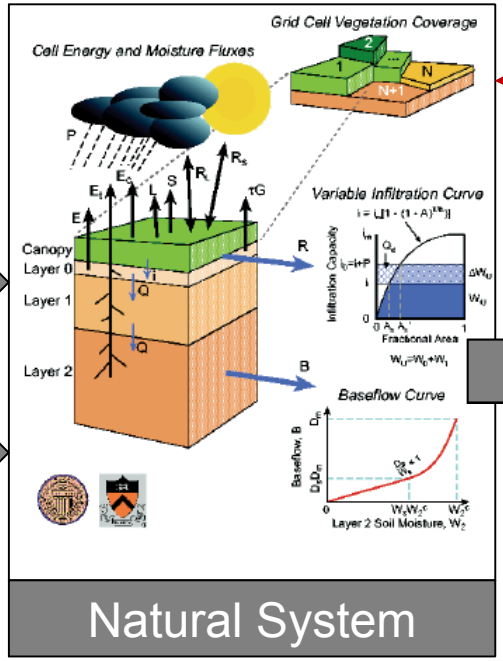
Next Speaker



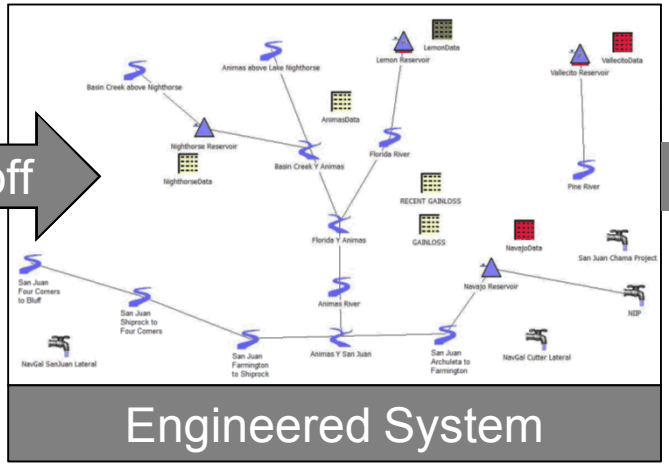
GC43C-1177
Katrina Bennett
Poster Thursday afternoon

Climate

Growth



Runoff



Deliveries

- Electric Power
- Agriculture
- Environment

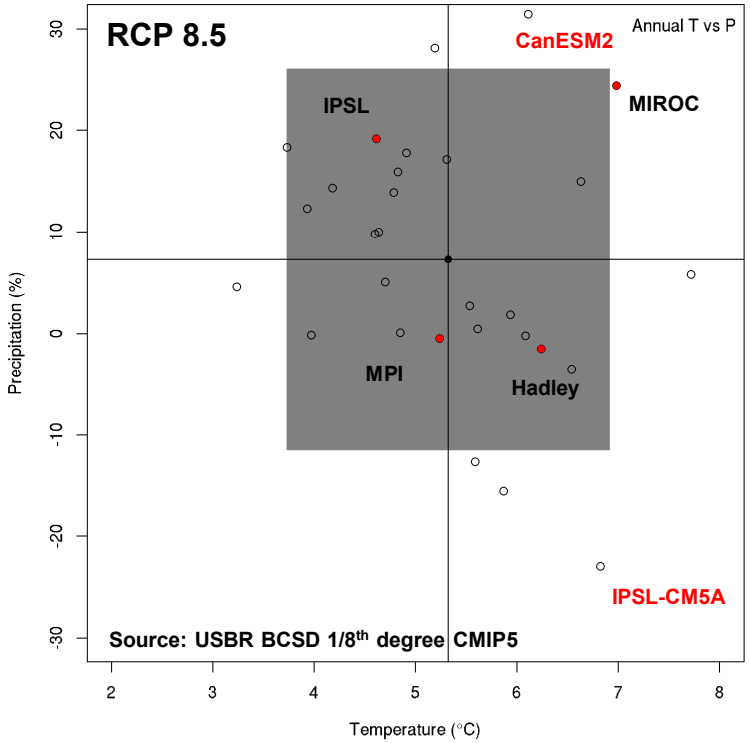
San Juan Basin

Four Corners Region

- Colorado River basin
- Snow melt dominated system
- Water Users
  - Native American
  - Irrigation
  - Multiple power plants and limited hydropower
  - Municipalities
  - Instream flows
  - Interbasin transfers

Model Scenarios

1. Six CMIP5 global climate models using scenario RCP 8.5



2. Climate Driven Vegetation Change (Fire, Infestation, Mortality)

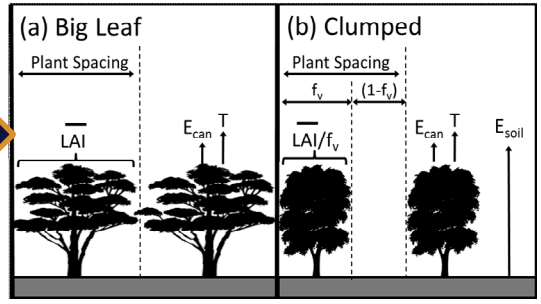
3. Growth Scenario

Navajo Indian Irrigation Project

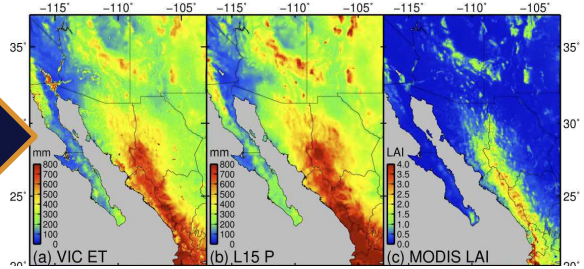
Methods: Hydrology

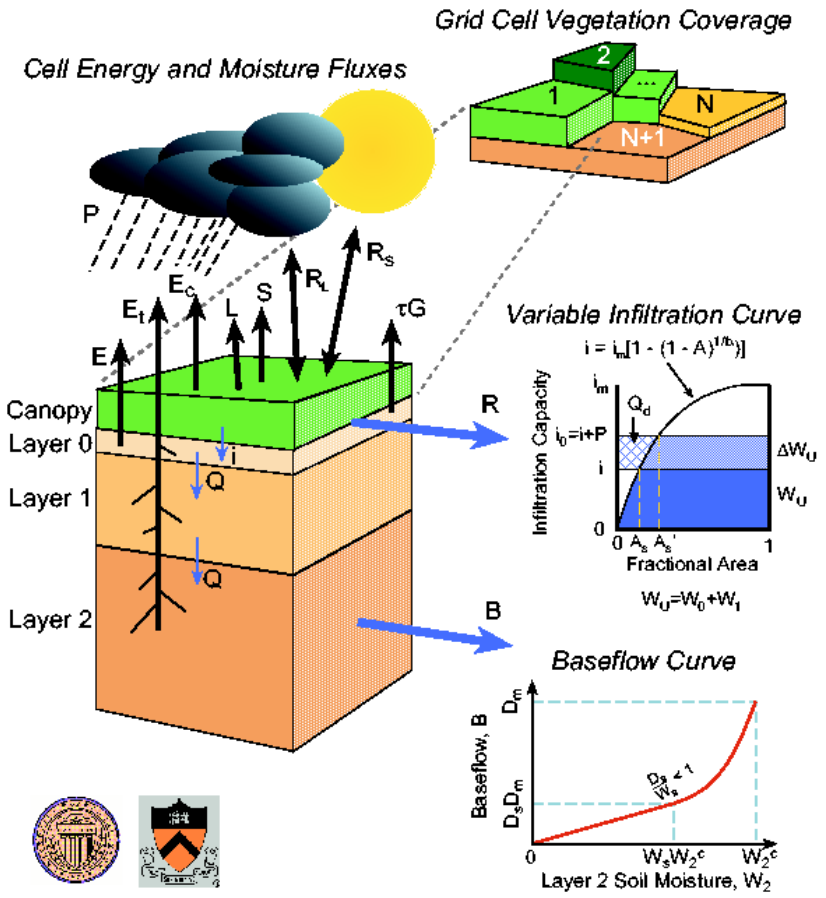
- Variable Infiltration Capacity (VIC) model at 1/16th degree
- New MODIS data, including time series for each grid cell for albedo, vegetation spacing and LAI
- Downscaling using Mutivariate Adaptive Constructive Analogues (MACA) data set (Abatzaglou and Brown, 2011)

VIC Version 4.2x



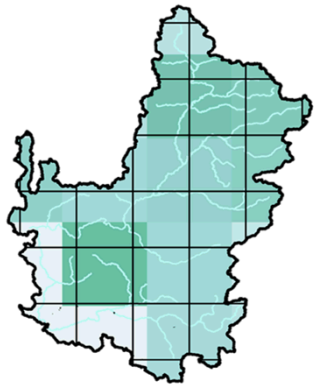
MODIS Veg; Livneh et al. 2015

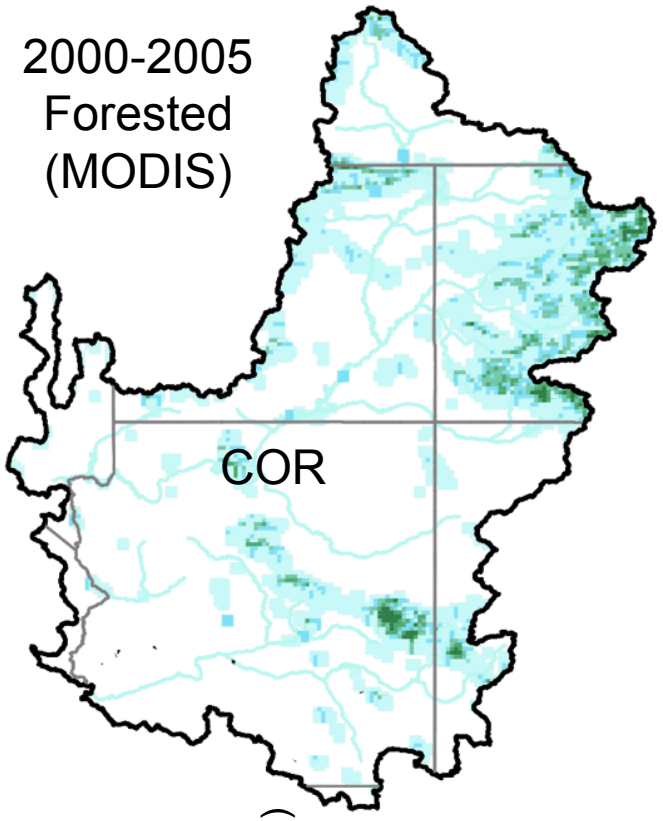


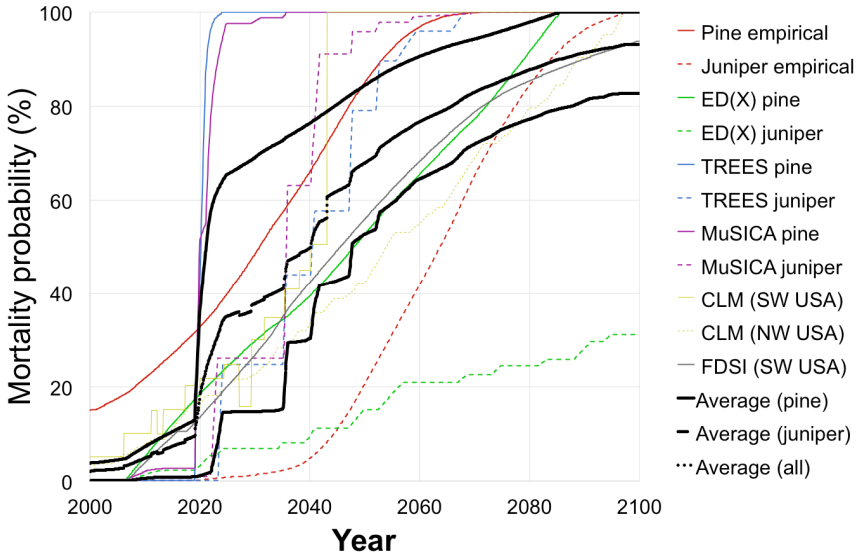


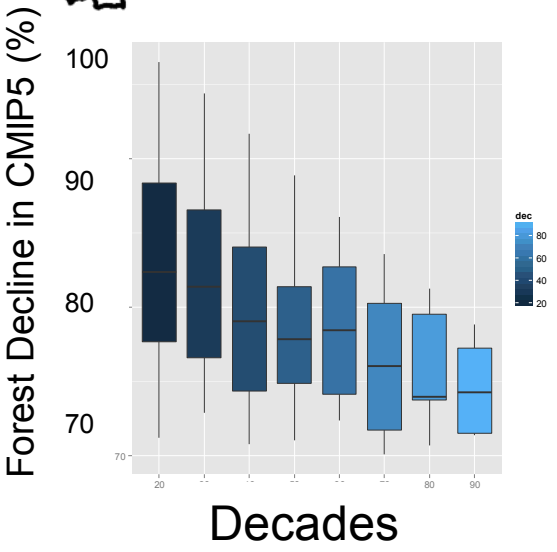
Bohn and Vivoni, 2015

Methods: Vegetation





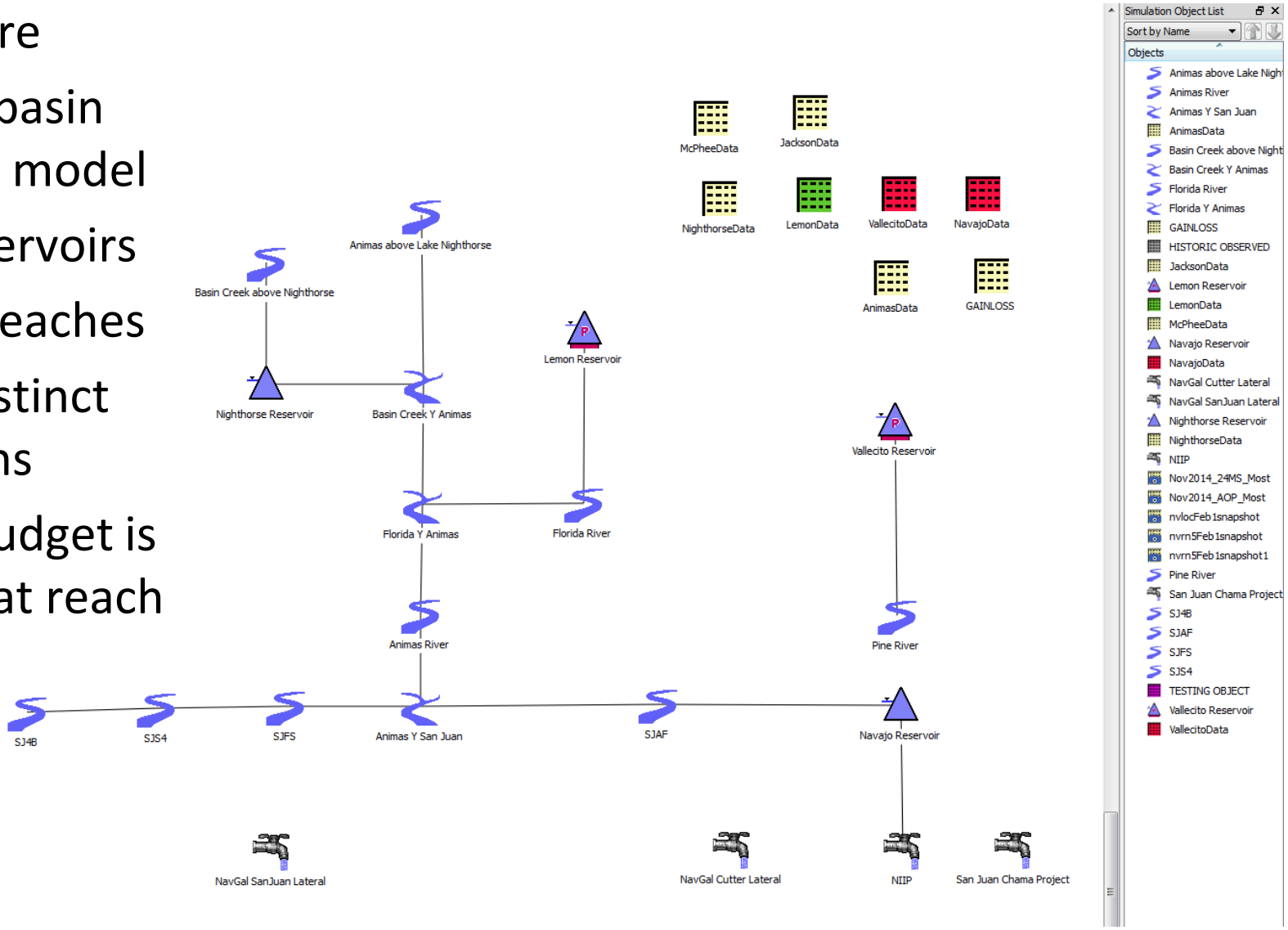




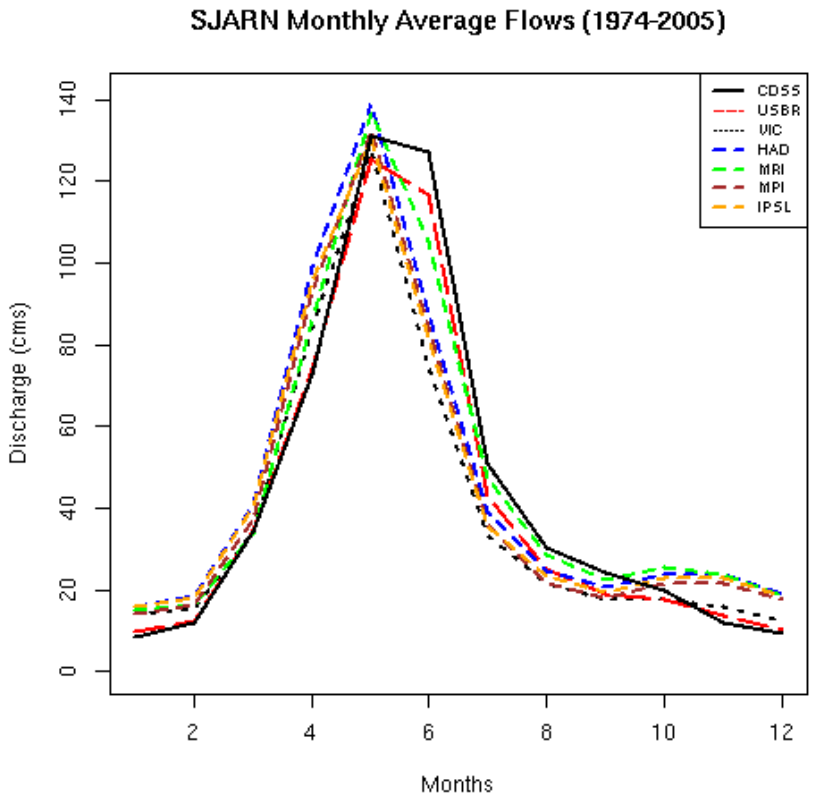
McDowell et al. Convergent predictions of massive conifer mortality due to chronic temperature rise. *Nature Climate Change.* 2015.

Methods: Reservoir Routing

- RiverWare
- Current basin planning model
- Four reservoirs
- Twelve reaches
- Three distinct diversions
- Water budget is lumped at reach level



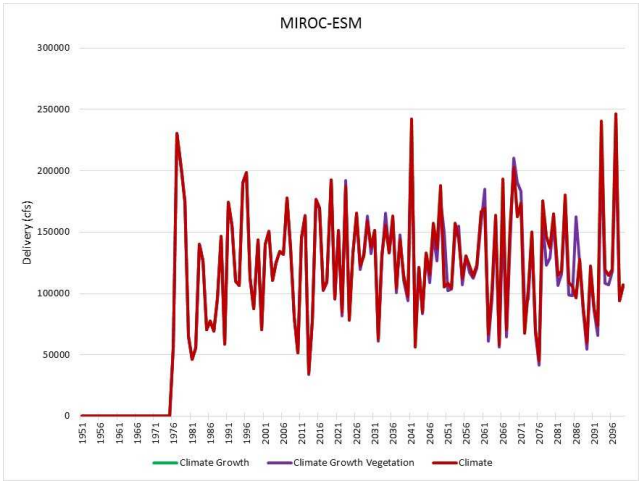
History Matching

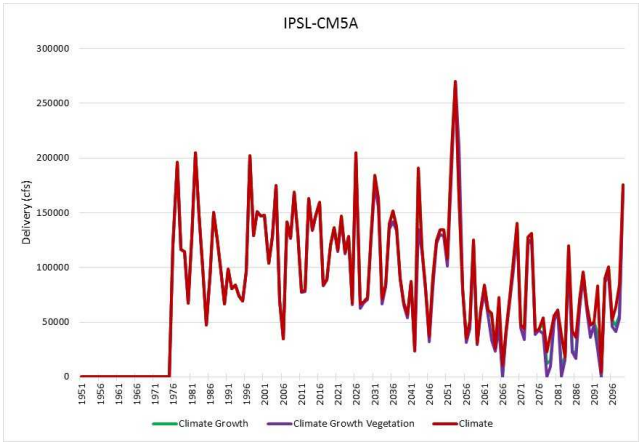


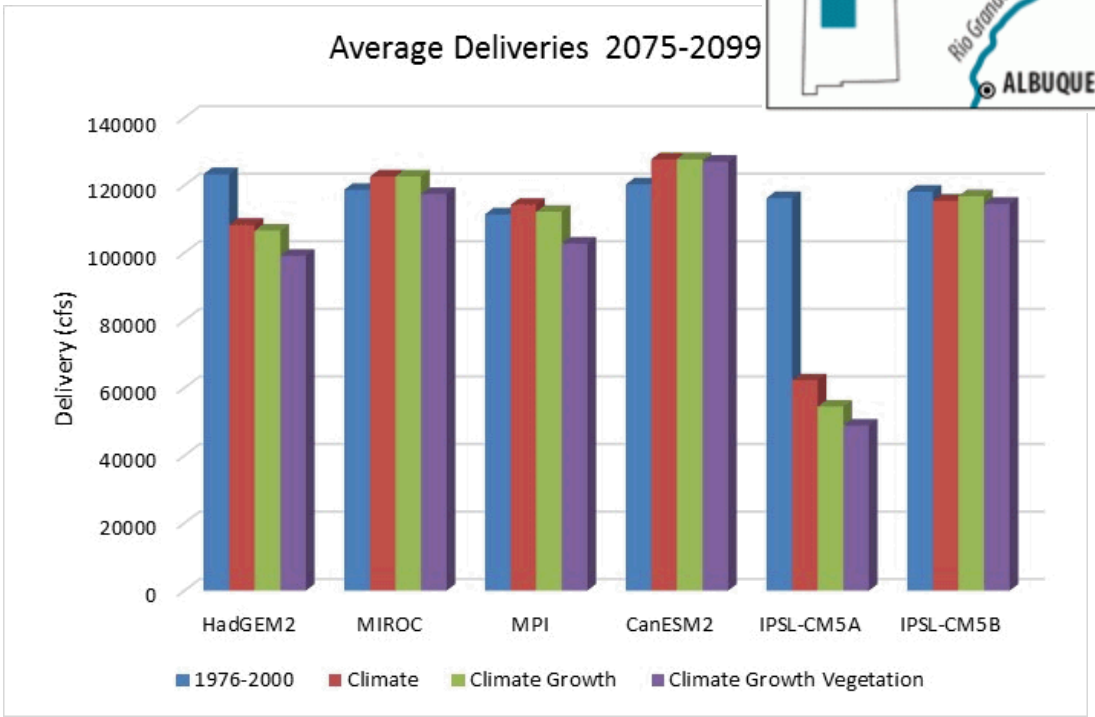
- Average monthly flows reproduced well except in June
- Calibration and validation accomplished at points just below Navajo Reservoir and the outlet to Lake Powell

Period of Analysis	**Statistic**	**SJARN**	**SJNBU**
Calibration (2006-2010)	Correlation Coefficient	0.91	0.90
Calibration (2006-2010)	Nash Sutcliffe	0.78	0.76
Calibration (2006-2010)	Nash Sutcliffe Log	0.77	0.75
Validation (2001-2005)	Correlation Coefficient	0.93	0.93
Validation (2001-2005)	Nash Sutcliffe	0.83	0.59
Validation (2001-2005)	Nash Sutcliffe Log	0.77	0.43
All (2001-2010)	Correlation Coefficient	0.90	0.91
All (2001-2010)	Nash Sutcliffe	0.81	0.67
All (2001-2010)	Nash Sutcliffe Log	0.78	0.58

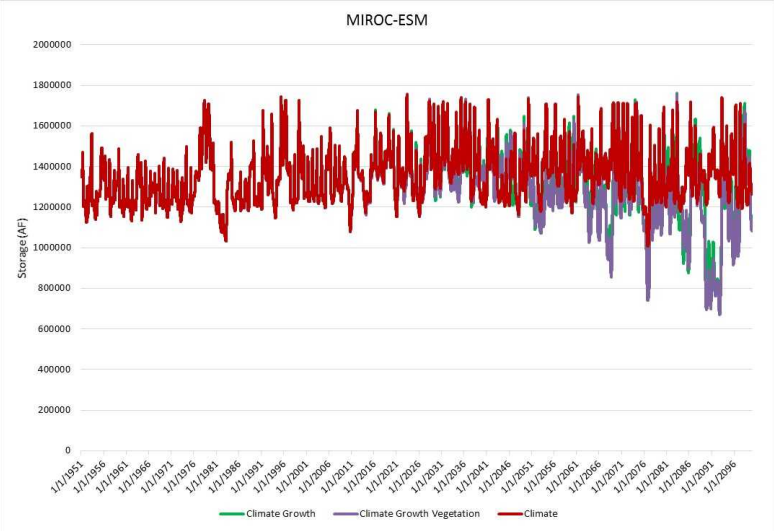
San Juan-Chama Deliveries



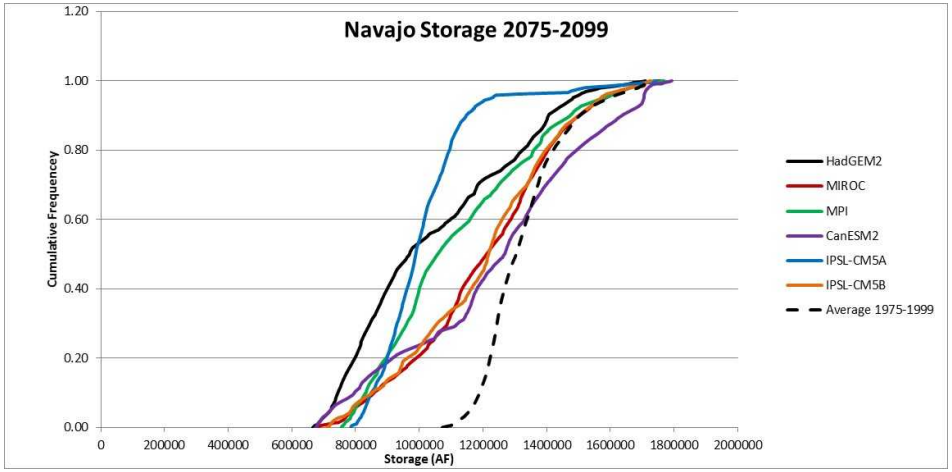


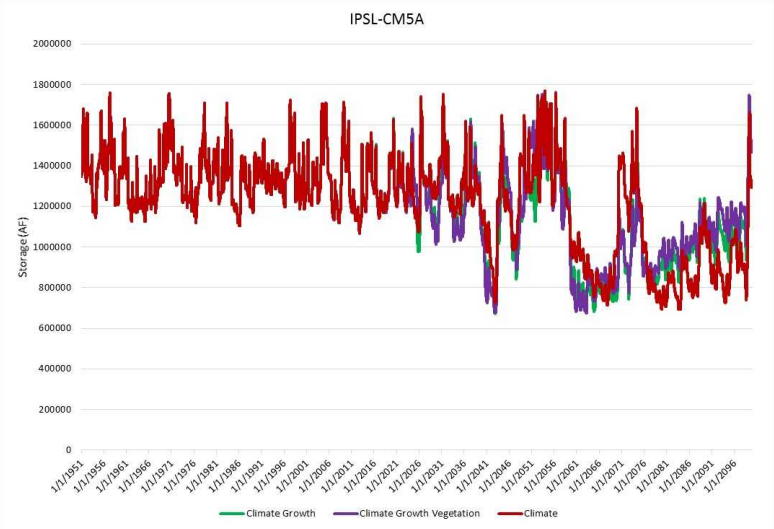


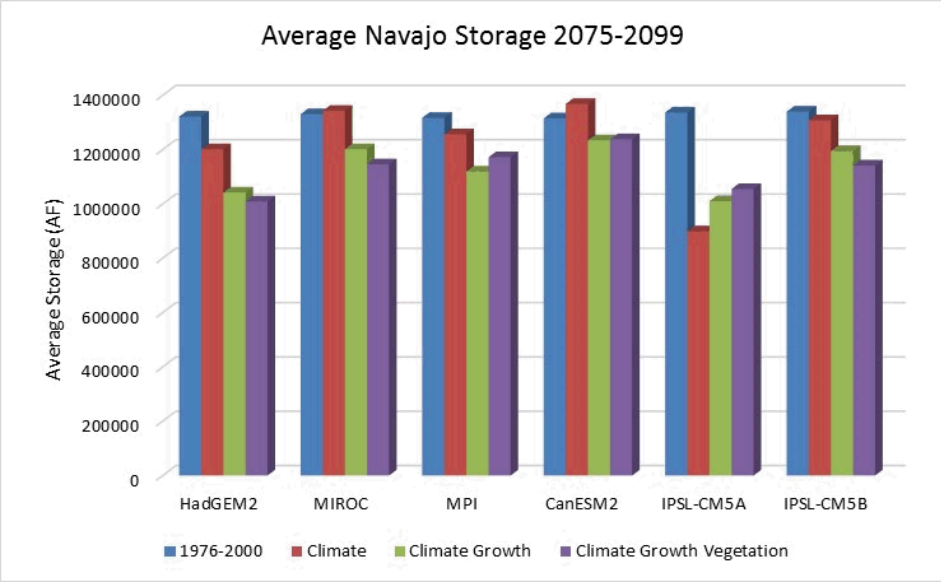
Navajo Reservoir Storage



Minimum Operating Storage 662,000 AF

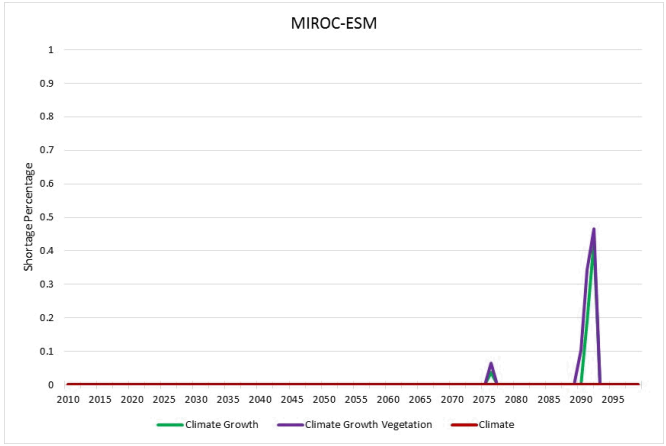


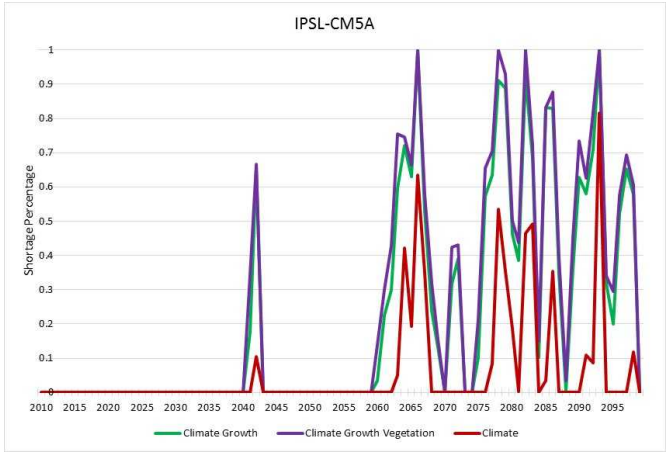


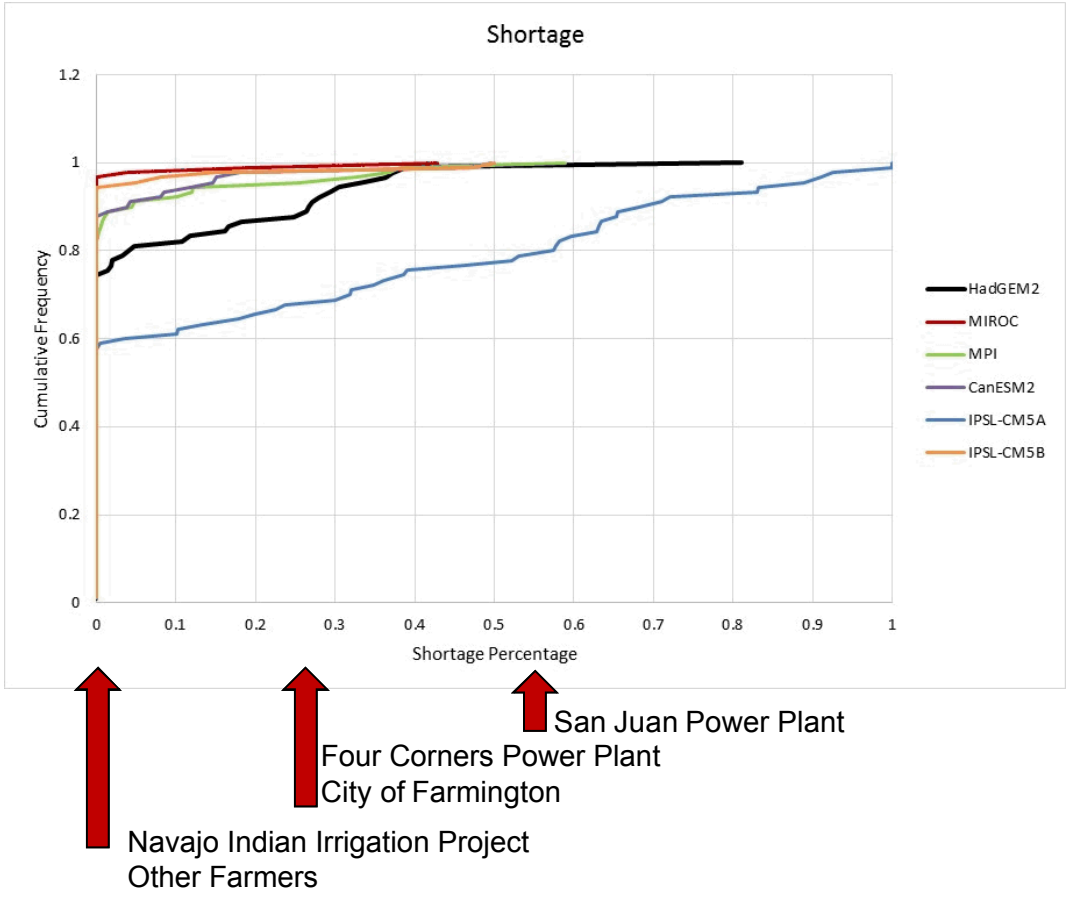


Water Deliveries

- Shortage sharing used to prioritize deliveries: all share equally in times of water shortage

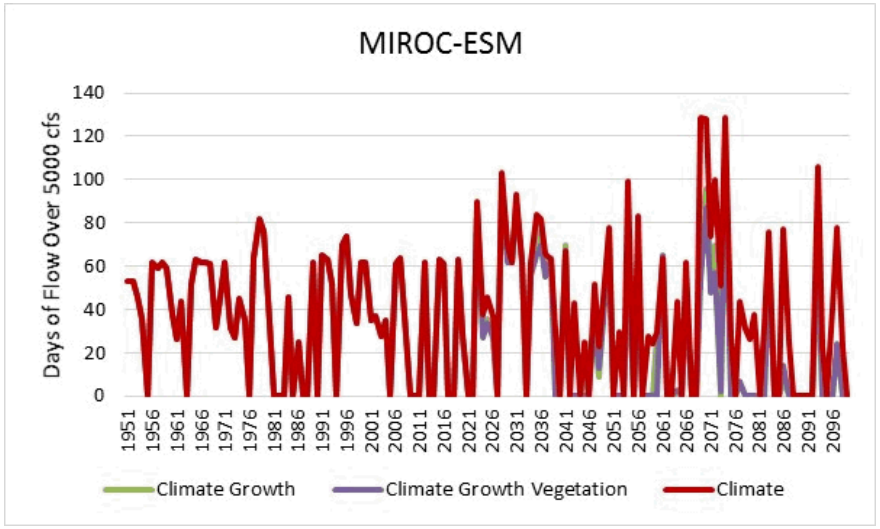


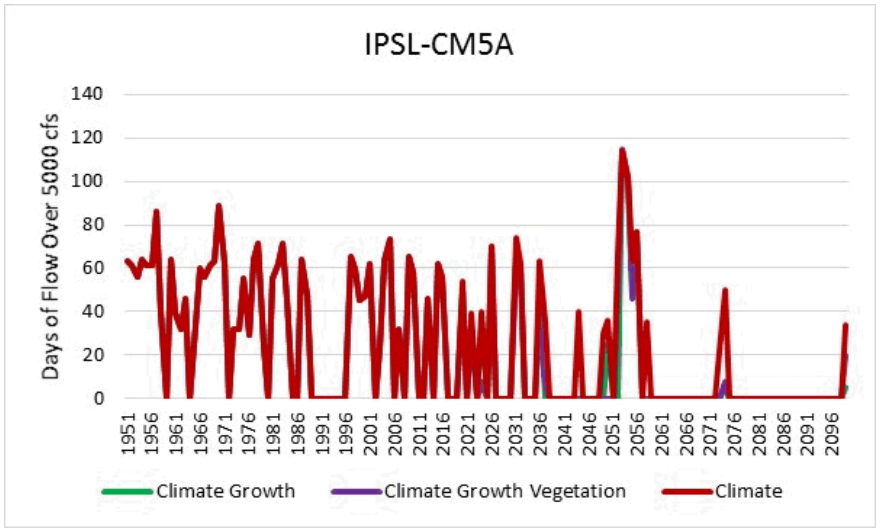


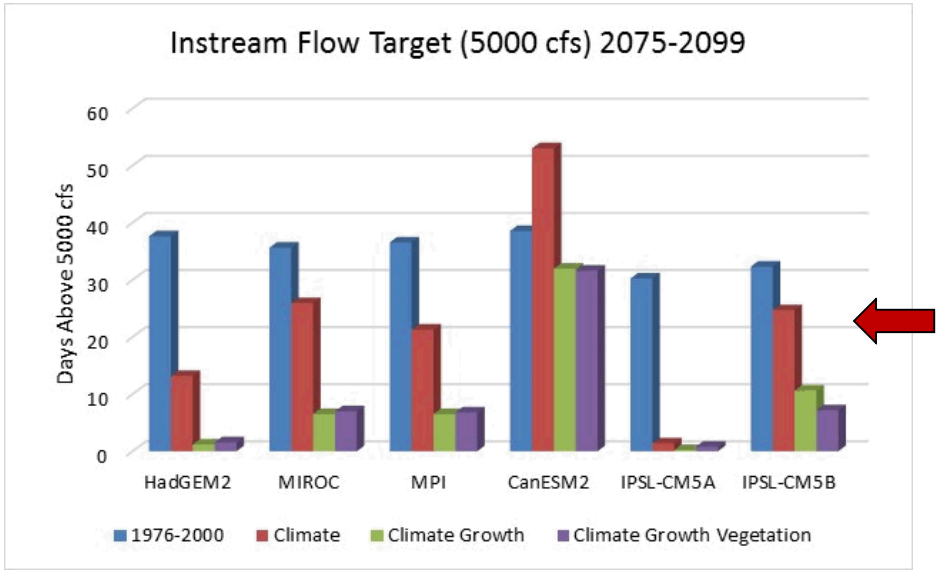


Target Instream Flows

Days above 5000 cfs: March-July
Target is 21 days per year

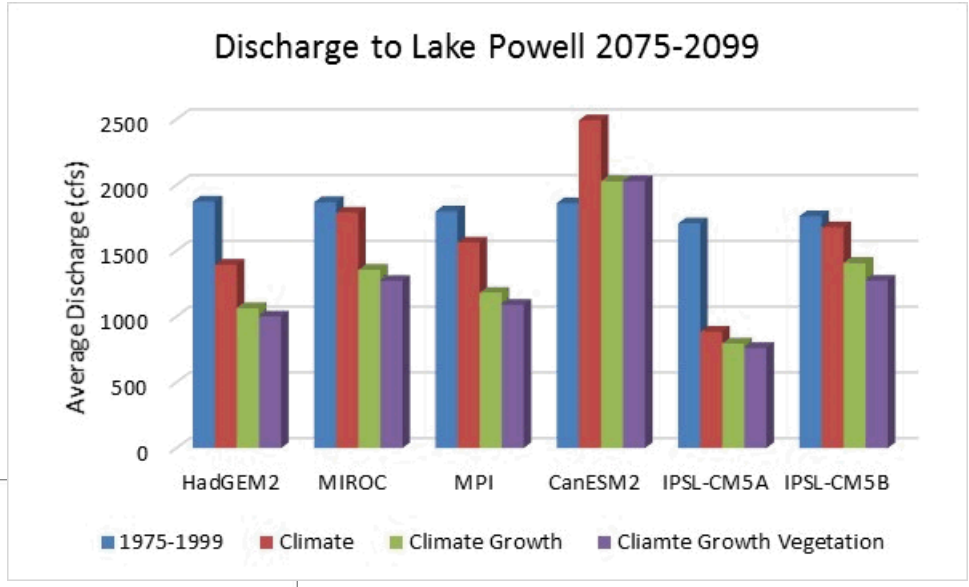


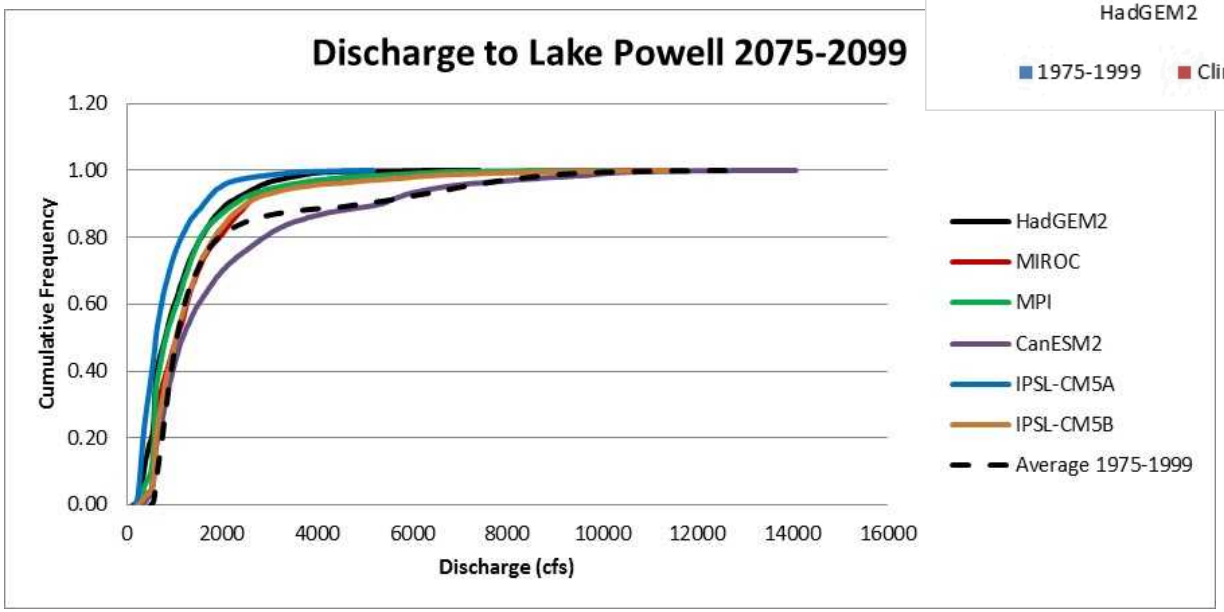




Deliveries on Colorado River

- One of three major upper basin tributaries to Colorado River
- Supplies about 18% of average annual flow



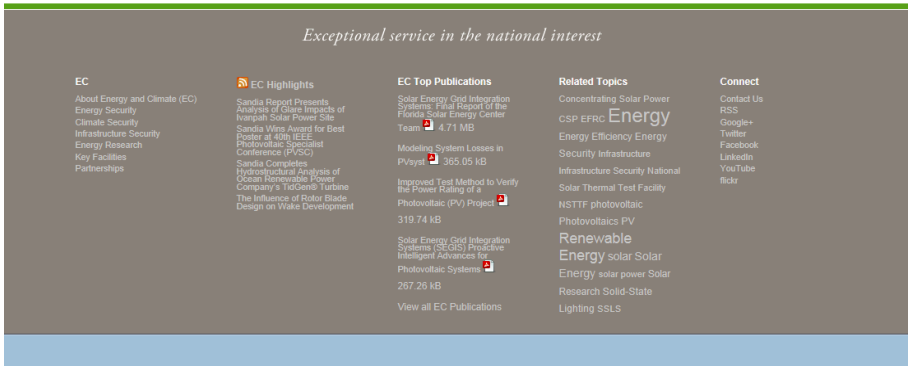


Summary

- ***Growth and Climate***: Only two models yielded delivery shortages under the climate only scenario; however when combined with growth all models registered multiple shortages.
- ***Uncertainty:*** Significant differences in projected impacts were consistently evident across climate models and scenarios.
- ***Uneven Impacts***: Impacts differ significantly by metric due to position in basin and the institutional controls dictating its operations.
- ***Non-Local Impacts***: Local effects of climate change spilled over to other basins:
  - Lower Colorado River, and
  - San Juan- Chama diversion to Rio Grande Basin.

- Project information:

http://water.sandia.gov



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