

Climate Change Summary, Lassen Volcanic National Park, California

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Historical Climate Trends for the Area within Park Boundaries

- Temperature and precipitation have decreased slightly since 1950 (Figures 1, 2; Table 1), but the rates were not statistically significant. Trends vary spatially across the park (Figures 3, 4).
- The part of California that includes the park is one of a few anomalous areas of the world that have not yet experienced historical warming. This may be due to wind changes from differences in heating with central California (Lebassi et al. 2009) or due to the ocean cycles of the Pacific Decadal Oscillation (Cordero et al. 2011), but the cause remains undetermined.

Historical Impacts Attributed to Climate Change

- Across the western U.S., including the area of the park, climate controlled the extent of burned area from 1916 to 2003 (Littell et al. 2009).
- Climate change has caused bark beetle outbreaks across the western U.S., including the area of the park, with outbreaks reaching their greatest extent in North America in 125 years (Raffa et al. 2008).
- Drought, wildfire, and bark beetles have doubling mortality from 1955 to 2007 in a set of forest plots across the western U.S. that include plots in the park (van Mantgem et al. 2007).
- Climate change reduced snowpack in the Cascades, Sierra Nevada, and across the western U.S. from 1950 to 1999 (Pierce et al. 2008).

Impacts Consistent with, but not Directly Attributed to Climate Change

- Ranges of a majority of bird species examined shifted upslope or downslope in the park between the 1920s and 2000s (Tingley et al. 2009, 2012; Rapacciuolo et al. 2014).
- Ranges of plant species shifted upslope or downslope in the park in the 20th century (Crimmins et al. 2011, Taylor 1995).

Projected Climate Trends for the Area within Park Boundaries

- If the world does not reduce emissions from cars, power plants, and deforestation 40 to 70%, models project substantial warming and increased precipitation (Figures 5-7; Table 1).
- Projected temperature and precipitation increases rise from west to east (Figures 5, 6).

Vulnerabilities in and around the Park

- Under high emissions, fire frequencies could increase up to 25% by 2100 (Moritz et al. 2012).
- Reduced snowpack and increase temperatures may alter hydrology of streams and rivers and reduce summer streamflow and water supplies in some areas (Garfin et al. 2014).
- Park ecosystems are vulnerable to future upslope shifts due to climate change (Gonzalez et al. 2010), exacerbated by habitat fragmentation (Eigenbrod et al. 2014).

Table 1. Historical and projected changes (data Daly et al. 2008, IPCC 2013; analysis Wang et al. in preparation). The table only gives central values. Figures 1-7 show the uncertainties.

	1950-2010	2000-2050	2000-2100
Historical			
temperature	-0.2°C/century (-0.4°F./century)		
precipitation	-11%/century		
Projected (compared to 1971-2000)			
Low emissions (IPCC RCP 4.5)			
temperature		+2°C (+3.6°F.)	+2.6°C (+4.7°F.)
precipitation		+3%	+3%
High emissions (IPCC RCP 6.0)			
temperature		+1.8°C (+3.2°F.)	+3°C (+5.4°F.)
precipitation		+1%	+6%
Highest emissions (IPCC RCP 8.5)			
temperature		+2.5°C (+4.5°F.)	+4.6°C (+8.3°F.)
precipitation		+4%	+7%

Figure 1. Historical annual average temperature for the area within park boundaries and 1950-2010 trend. (Data: Daly et al. 2008, IPCC 2013. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

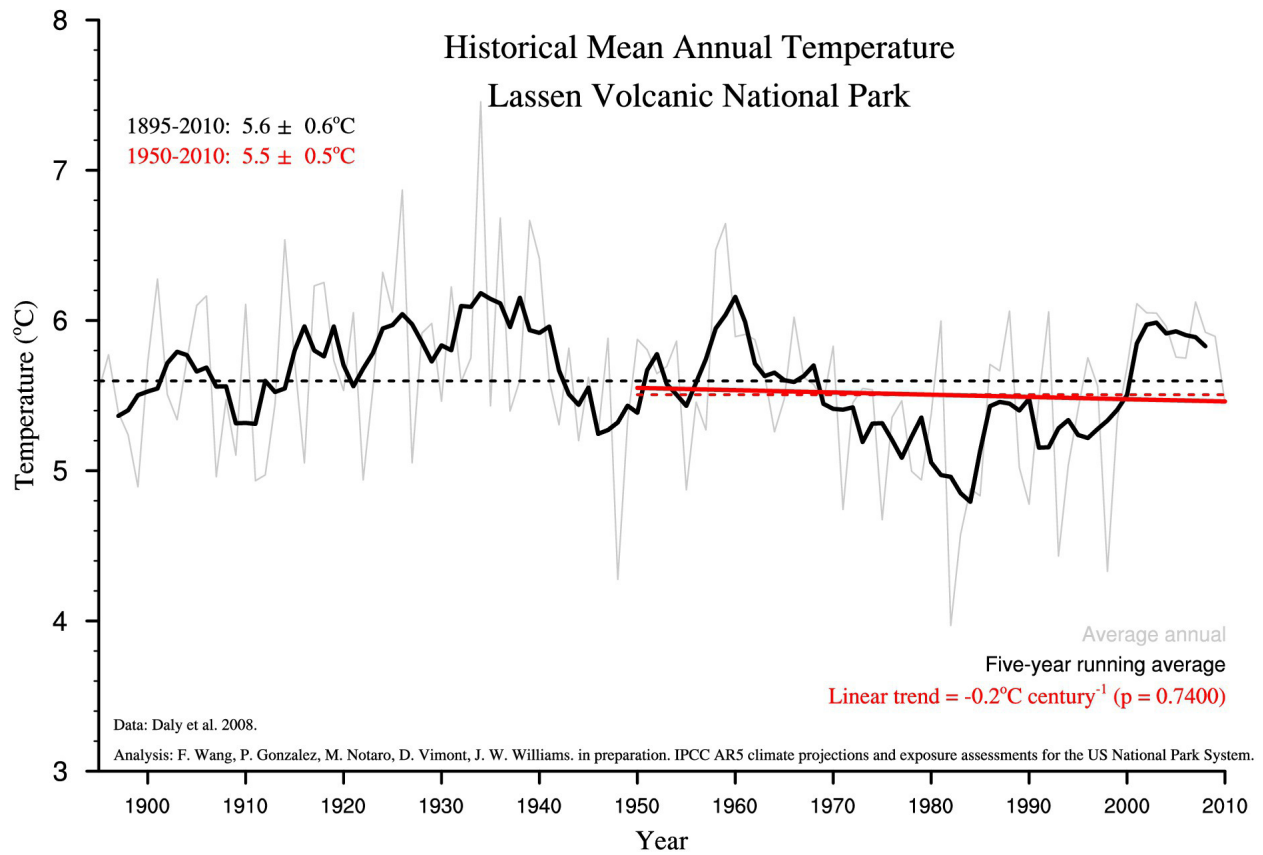


Figure 2. Historical annual total precipitation for the area within park boundaries and 1950-2010 trend. (Data: Daly et al. 2008, IPCC 2013. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

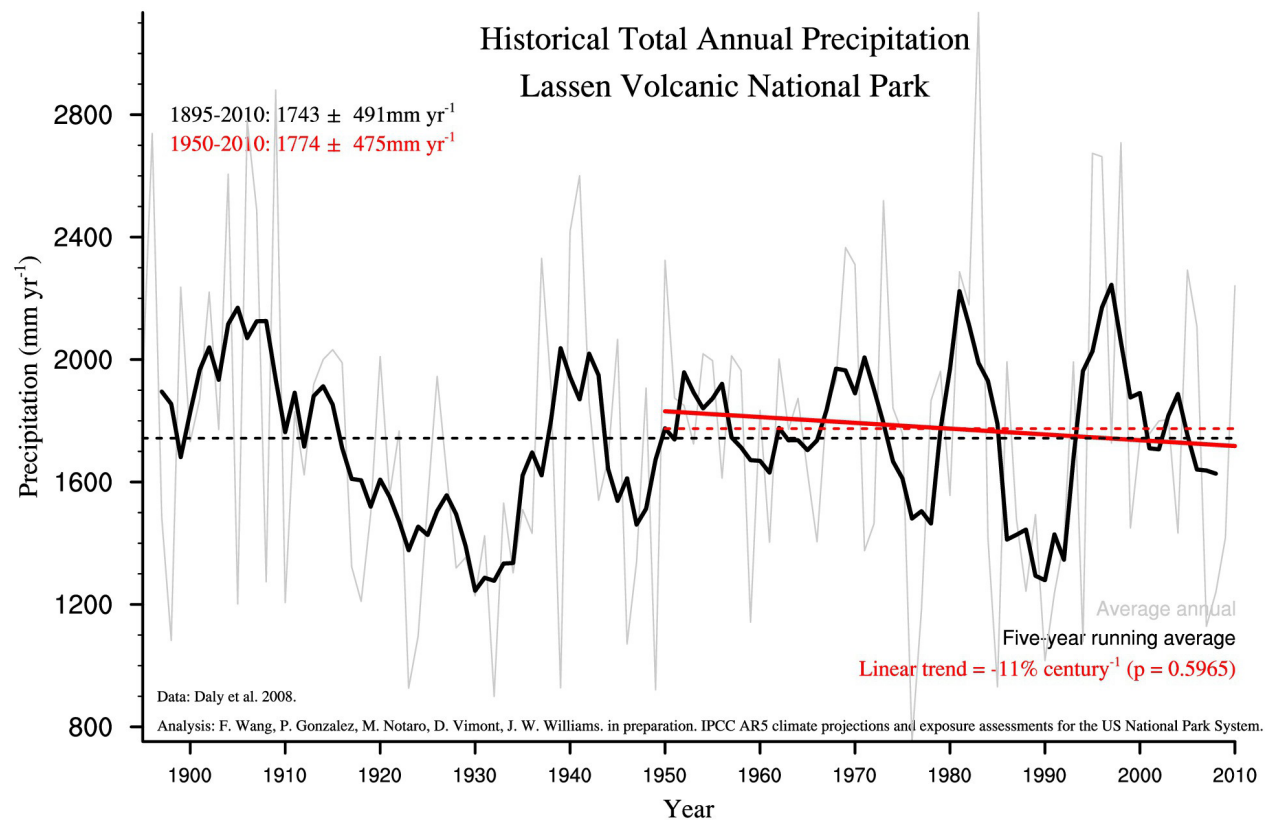
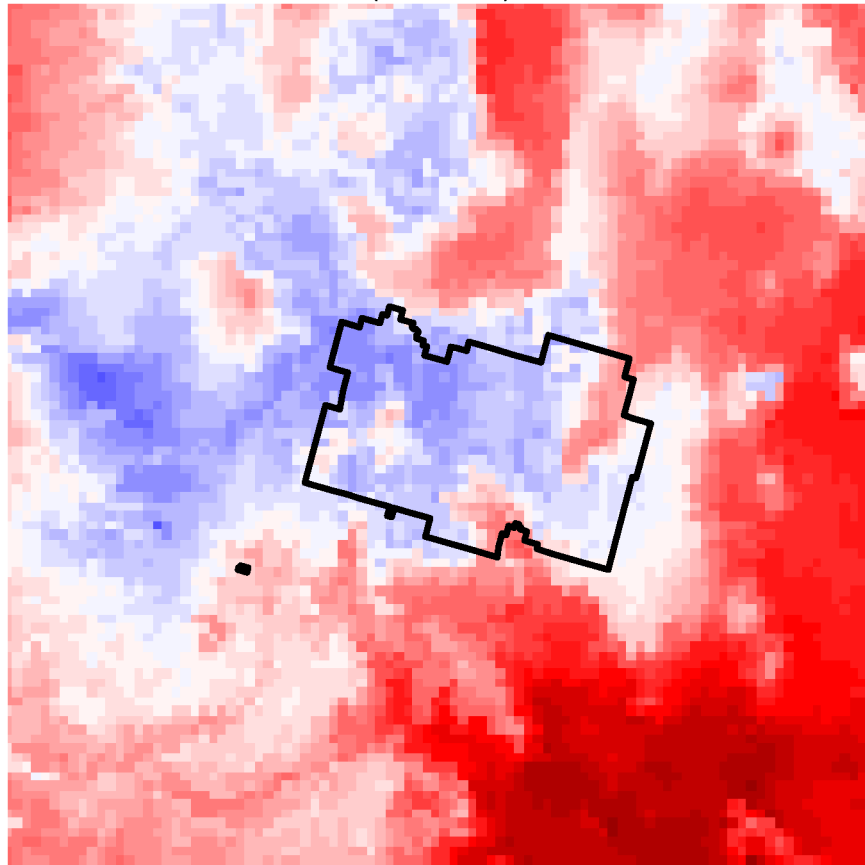


Figure 3. Historical annual average temperature rate of change, 1950-2010. (Data: Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

Linear Trend in Historical Mean Annual Temperature ($^{\circ}\text{C century}^{-1}$)
Lassen Volcanic National Park
(1950 - 2010)

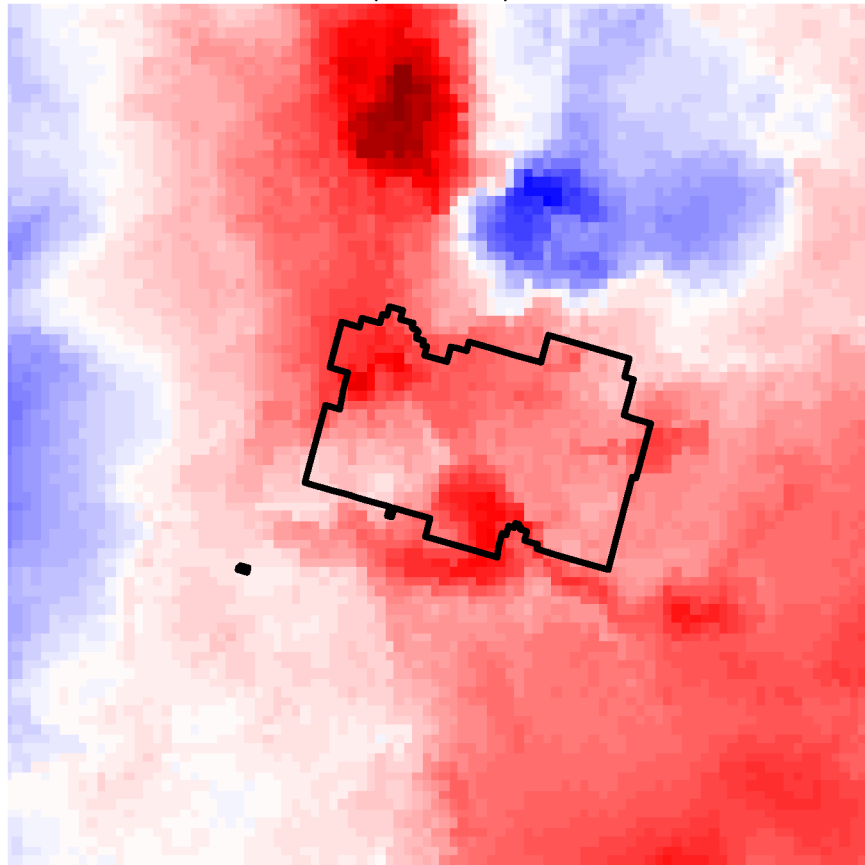


Data: IPCC 2013. Daly et al. 2008. Analysis: F. Wang, P. Gonzalez, M. Notaro, D. Vimont, J. W. Williams.



Figure 4. Historical annual total precipitation rate of change, 1950-2010. (Data: Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

Linear Trend in Historical Total Annual Precipitation (%)
Lassen Volcanic National Park
(1950 - 2010)



Data: IPCC 2013. Daly et al. 2008. Analysis: F. Wang, P. Gonzalez, M. Notaro, D. Vimont, J. W. Williams.



Figure 5. Projected change in annual average temperature under emissions scenario RCP6.0, 2000-2100. (Data: IPCC 2013, Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

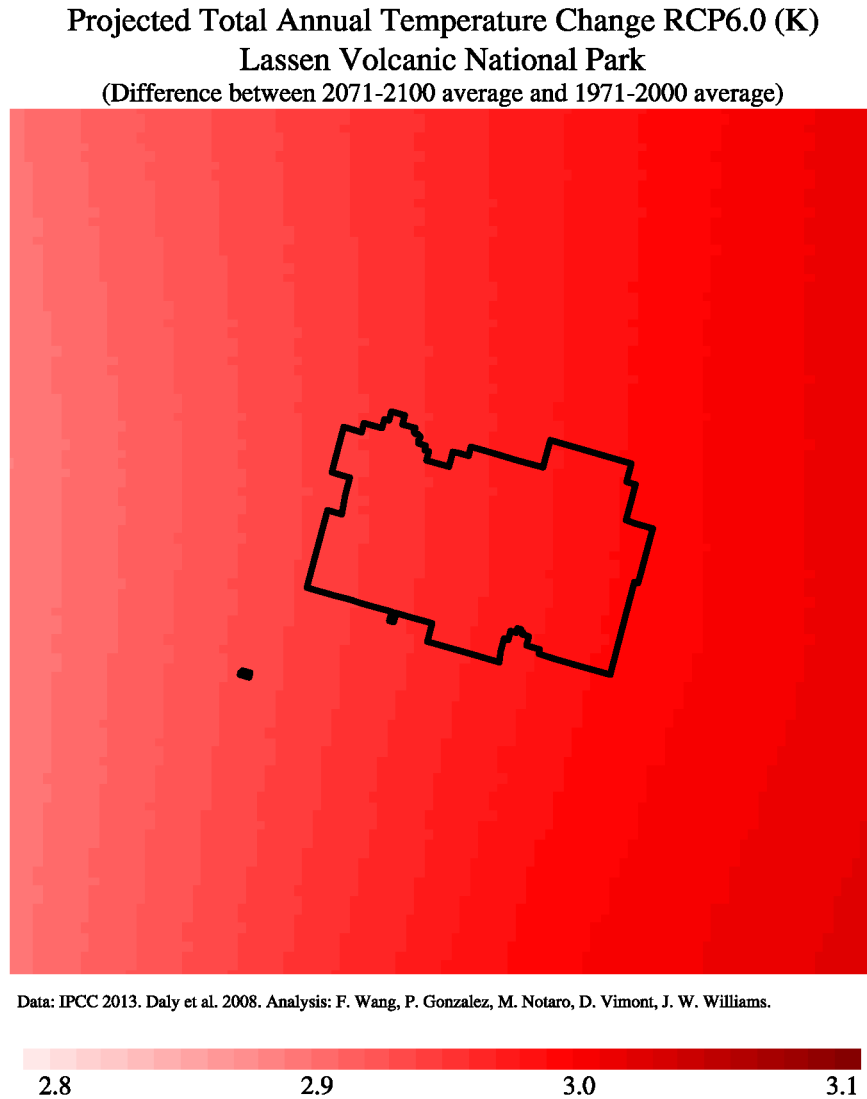


Figure 6. Projected change in annual total precipitation under emissions scenario RCP6.0, 2000-2100. (Data: IPCC 2013, Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

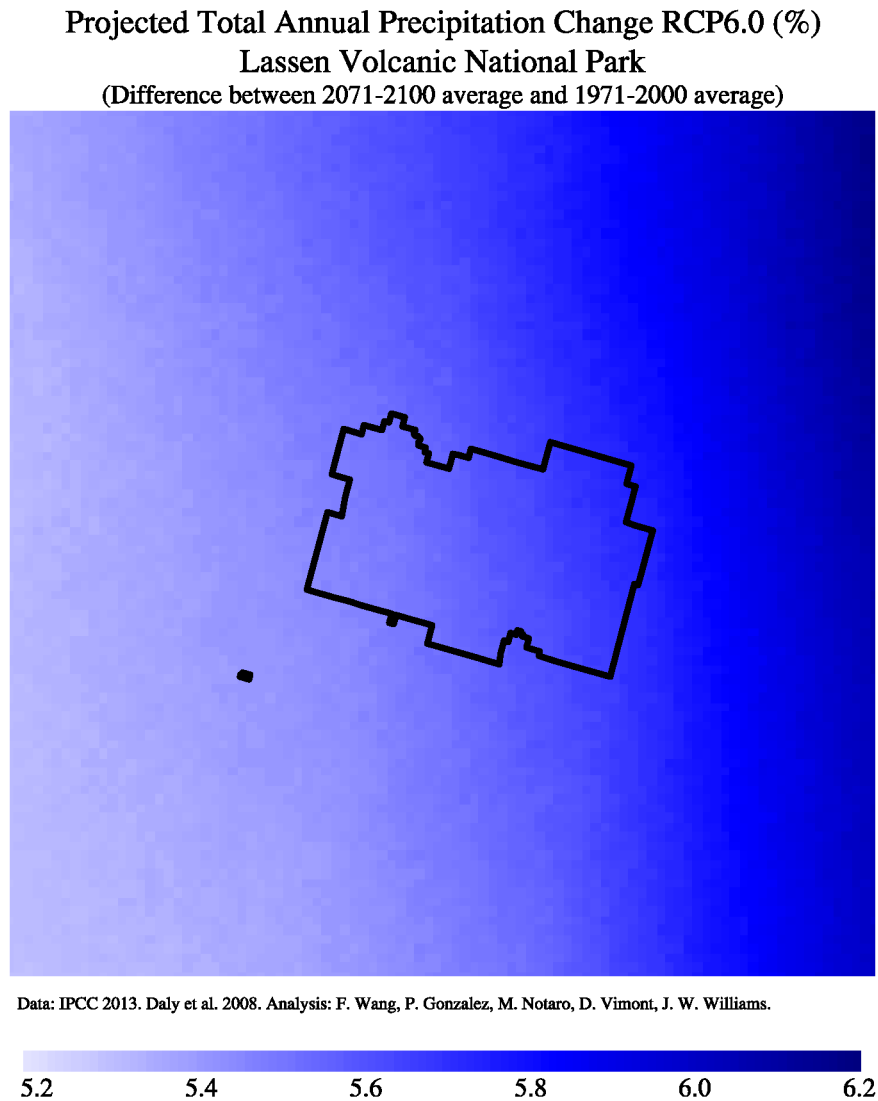
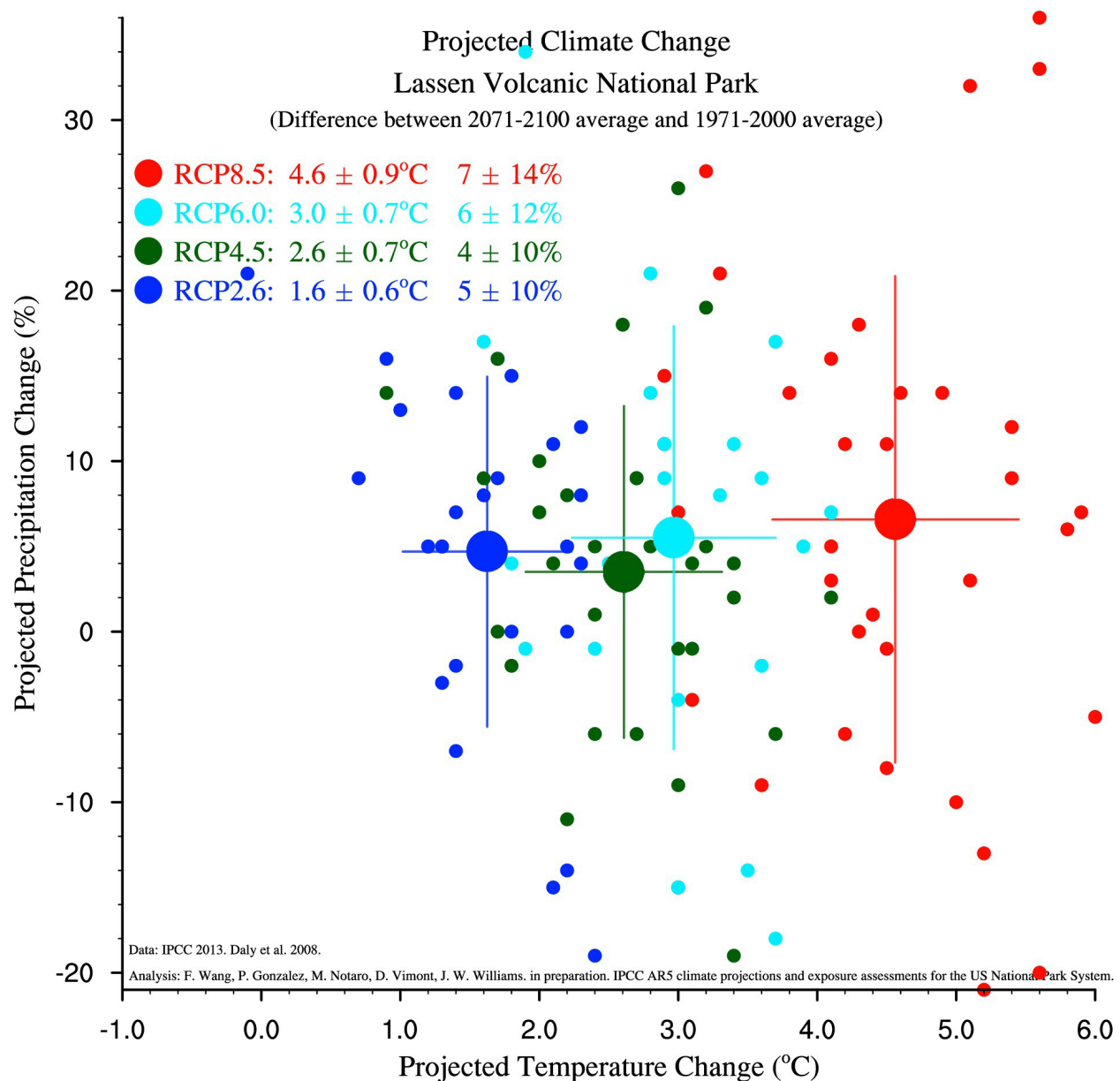


Figure 7. Projections of future climate for the area within park boundaries. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value. (Data: IPCC 2013, Daly et al. 2008; Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).



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