

Twentieth and Twenty-First Century Climate Trends at Mesa Verde National Park and Yucca House National Monument, Colorado

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Introduction

Greenhouse gas emissions from vehicles, power plants, deforestation, and other human activities have increased temperatures around the world and changed other aspects of climate (IPCC 2013). Published field research shows that climate change is also altering ecosystems by shifting biomes, contributing to species extinctions, and causing numerous other changes (IPCC 2007b). To assist Mesa Verde National Park and Yucca House National Monument integrate climate change into resource management, this report presents results of spatial analyses of historical and projected climate.

Historical Climate Changes

From 1901 to 2002, mean annual temperature increased across the western United States (U.S.) (Figure 1) and showed a statistically significant increase in the area that includes the two parks (Figure 2, Table 1). From 1901 to 2002, precipitation decreased across the southwestern U.S. (Figure 3), although it showed no statistically significant trend in the area of the parks (Figure 4). Although the weather station in Mesa Verde national Park has provided data from 1922 to 2012, the station has been moved through four locations and up in elevation by 43 m. Because temperature naturally decreases as elevation increases, the data would have needed careful adjustment for proper use for long-term trends.

Future Climate Projections

The Intergovernmental Panel on Climate Change (IPCC) has coordinated research groups to project possible future climates under defined greenhouse gas emissions scenarios (IPCC 2013). Three IPCC greenhouse gas emissions scenarios evaluated here are B1 (lower emissions), A1B (medium emissions), and A2 (higher emissions). Actual global emissions are on a path above IPCC emissions scenario A2 (IPCC 2013, Raupach et al. 2007).

For the three emissions scenarios, projected 21st century temperature in the Colorado NM area

could increase three to six times the amount of historical 20th century warming (Table 1, Mitchell and Jones 2005, Gonzalez et al. 2010). The average of the projections of available general circulation models (GCMs) of the atmosphere indicate slightly increased precipitation for the area of the parks under all two scenarios and decreased precipitation under emissions scenario A2 (Table 1). For A2, 13 out of 18 GCMs project decreases in precipitation (Figure 5; historical average from Mitchell and Jones 2005, Hijmans et al. 2005; projections from IPCC 2007a, Tabor and Williams 2010, Conservation International; analysis by P. Gonzalez).

Projections indicate potential changes in the frequency of extreme temperature and precipitation events. Modeling under emissions scenario A2 projects 15 to 25 more days with a maximum temperature > 35°C, 25 to 30 fewer days with a minimum temperature < 0°C, and 10 to 15 more consecutive days with precipitation < 3 cm between the periods 1980-2000 and 2041-2070 (Kunkel et al. 2013).

Table 1. Historical and projected climate trends for the area that includes Mesa Verde National Park and Yucca House National Monument (Mitchell and Jones 2005, IPCC 2013, Gonzalez et al. 2010). Historical climate and projections for IPCC emissions scenarios B1 and A1B calculated for the 50 x 50 km pixels that include the parks (Gonzalez et al. 2010). Climate under emissions scenario A2 calculated for the 4 x 4 km pixels that include the parks (data from Conservation International, using method of Tabor and Williams (2010)). Standard error (SE) for historical trends; standard deviation (SD) for other variables.

	mean	SD/SE	units
Historical 1901-2002			
temperature annual average	8.1	0.7	°C
temperature linear trend [SE]	0.8	0.2	°C/century
precipitation annual average	430	100	mm/y
precipitation linear trend [SE]	-2	8	%/century
Projected (1990-2100)			
IPCC B1 scenario (lower emissions)			
temperature change in annual average	2.9	1.1	°C/century
precipitation change in annual total	+1	6	%/century
IPCC A1B scenario (medium emissions)			
temperature change in annual average	3.8	1.1	°C/century
precipitation change in annual total	+4	6	%/century
IPCC A2 scenario (higher emissions)			
temperature change in annual average	4.8	1.1	°C/century
precipitation change in annual total	-6	6	%/century

Figure 1.

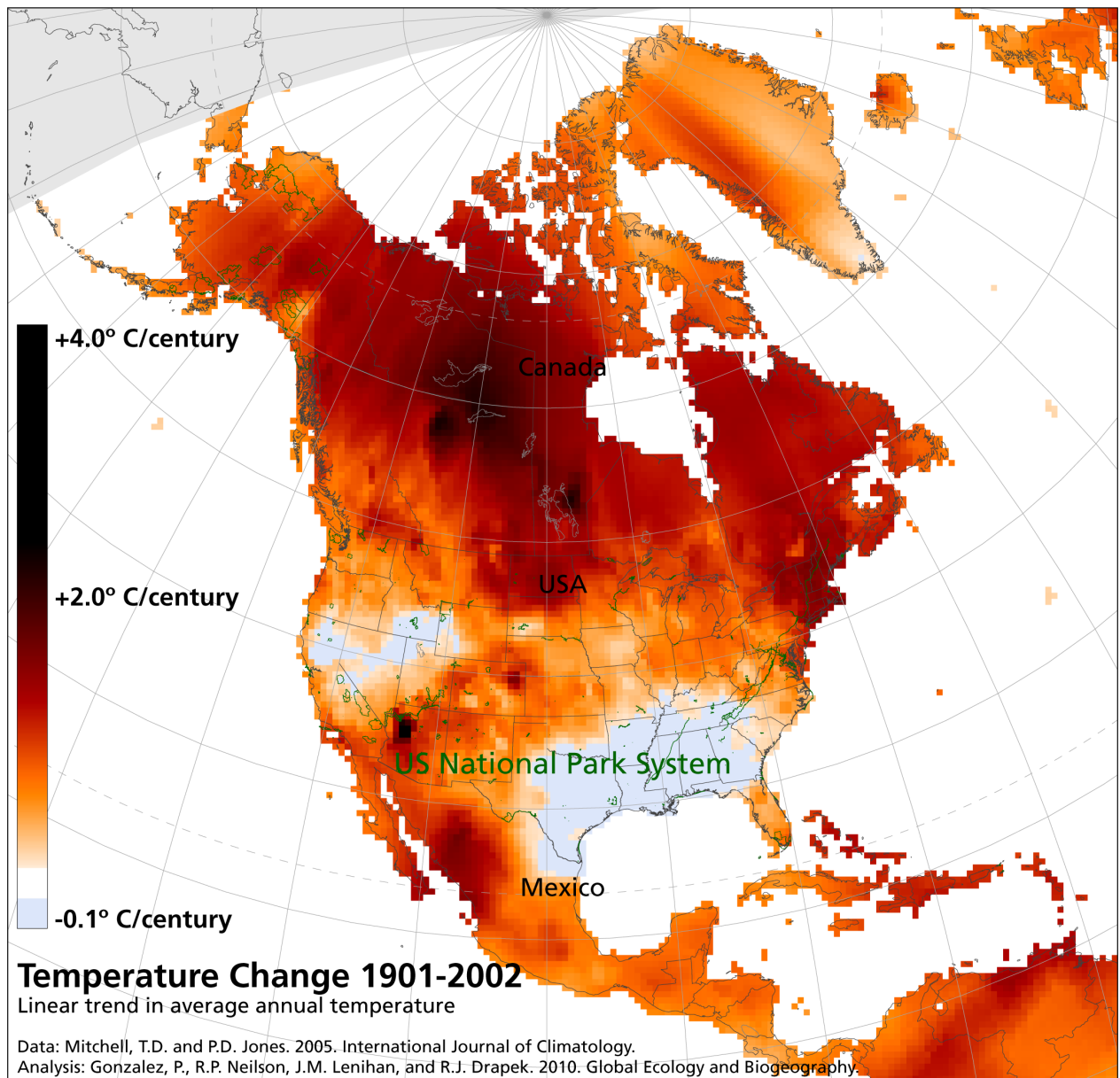


Figure 2.

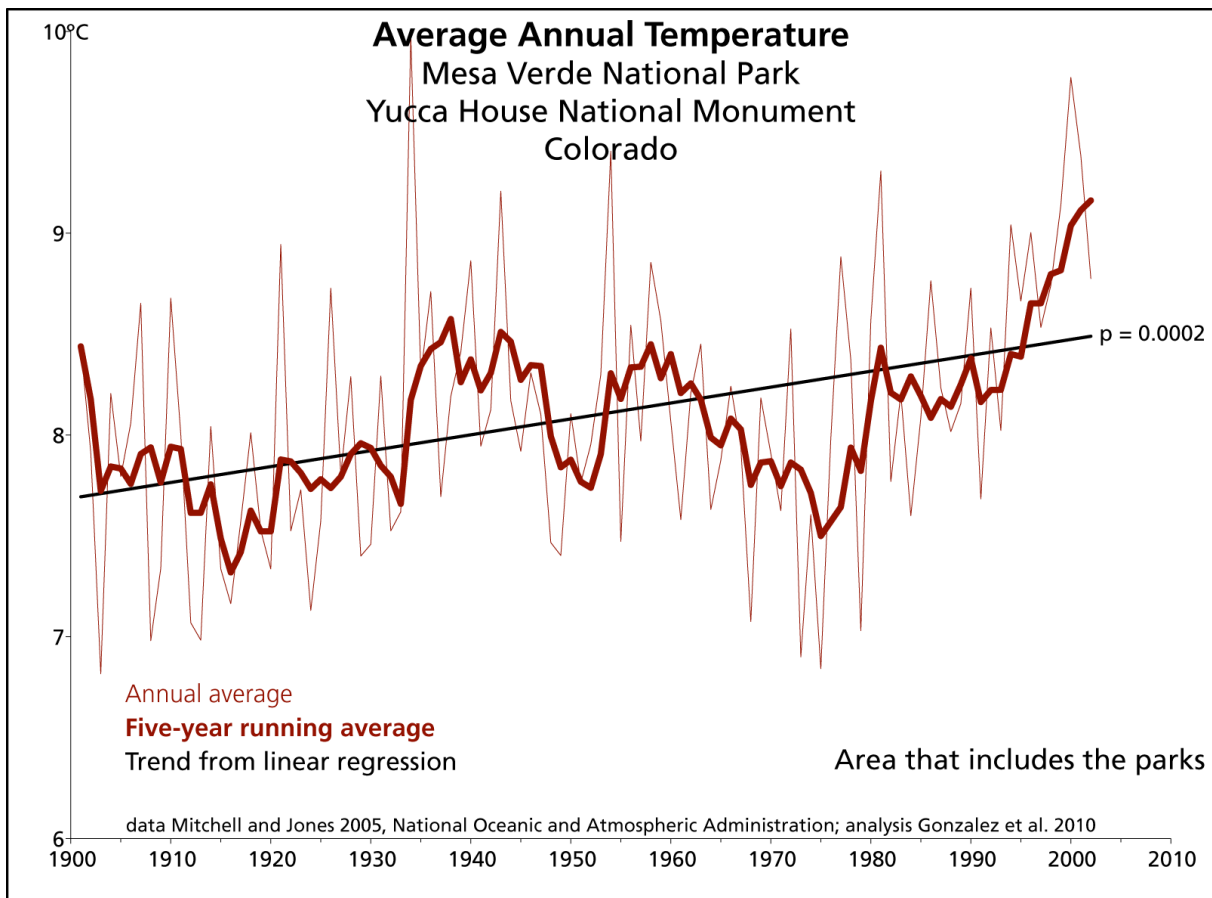


Figure 3.

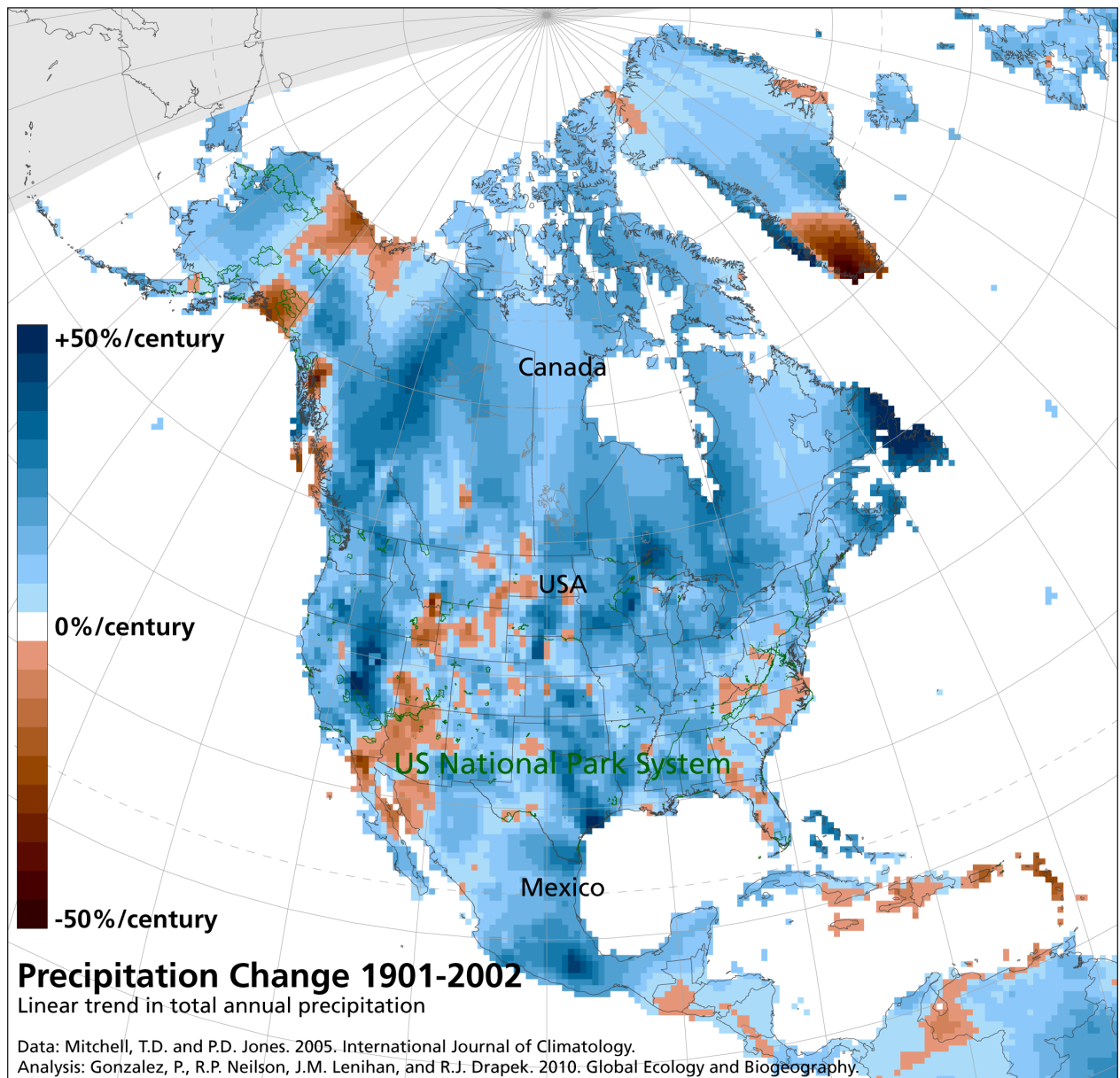


Figure 4.

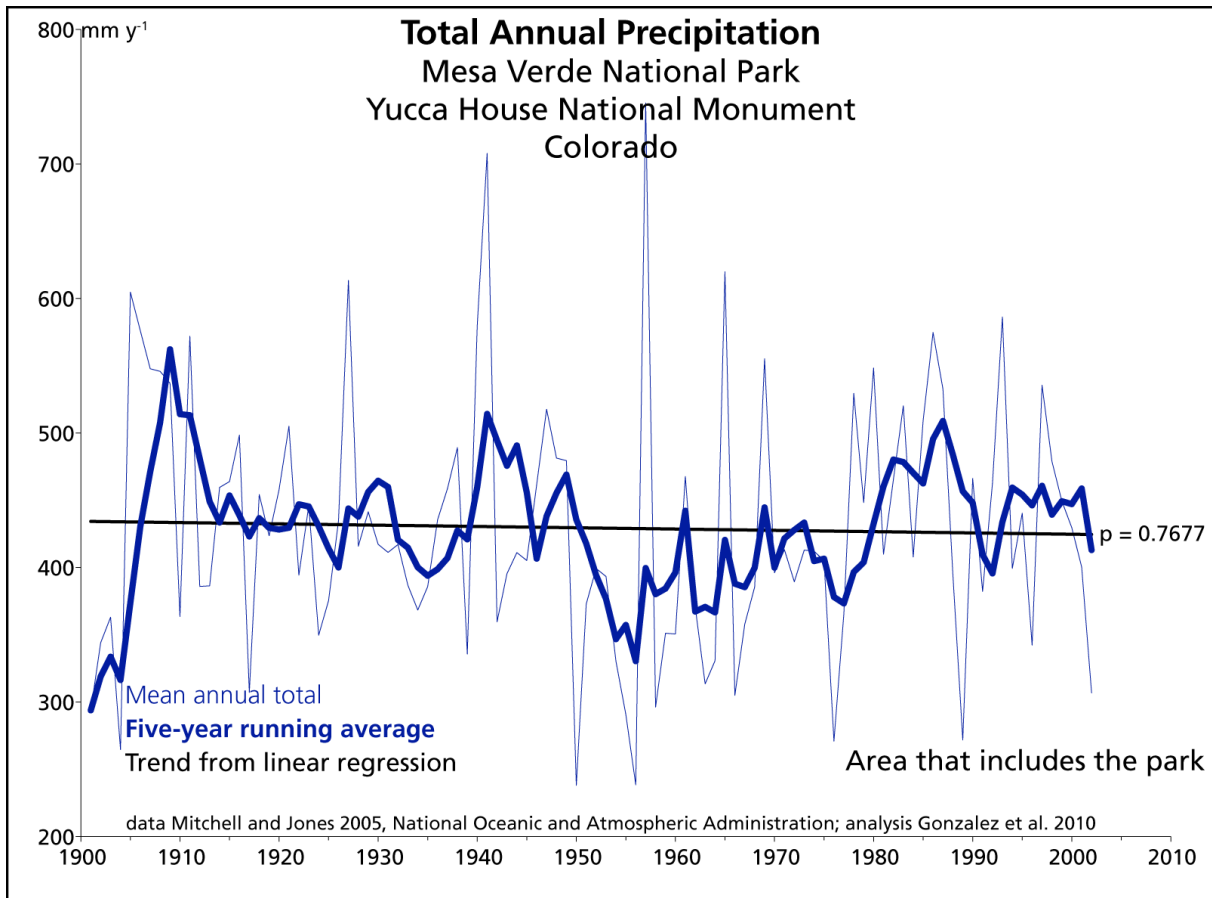
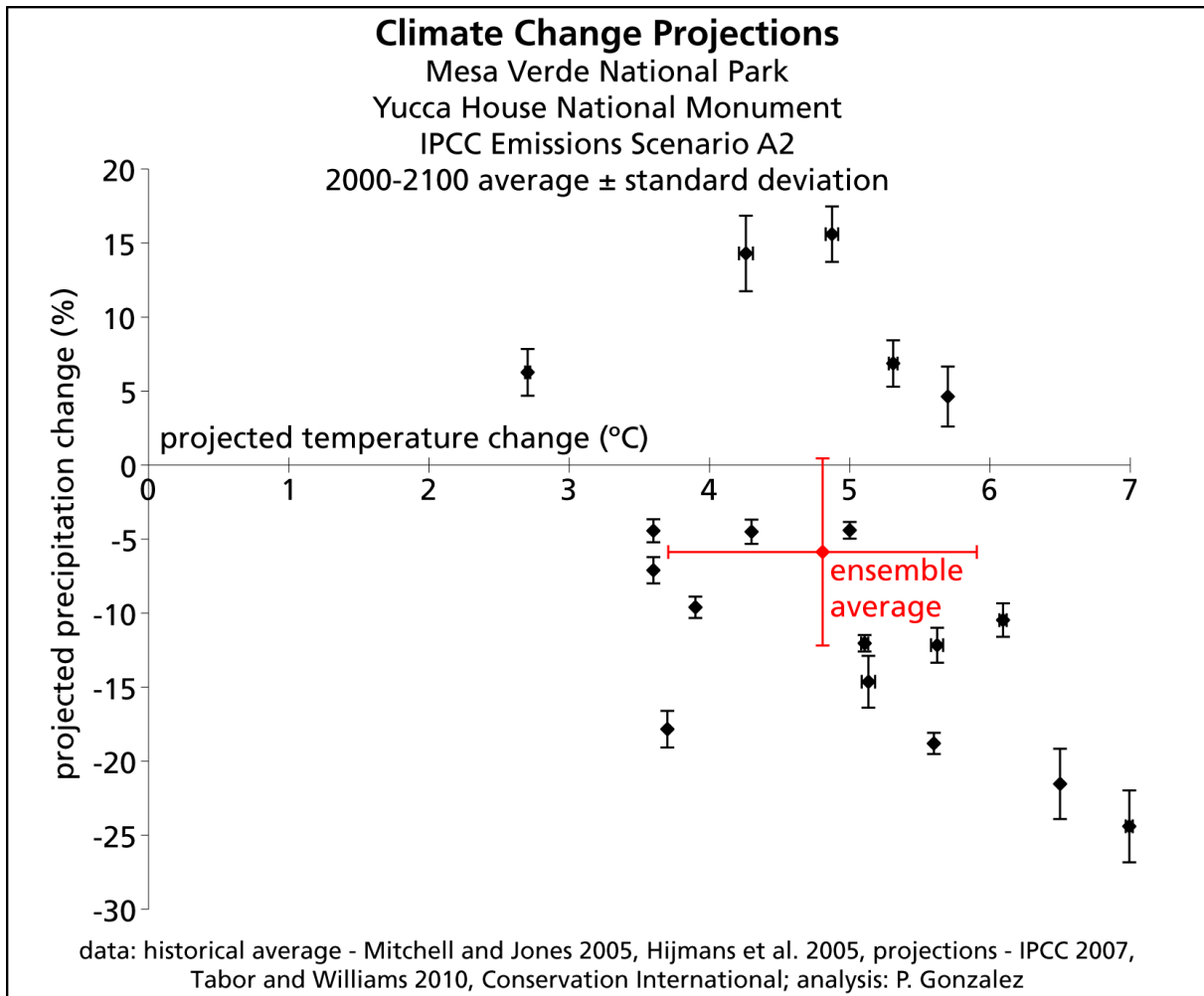


Figure 5.



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