

## **Climate Change Summary, Wright Brothers National Memorial, North Carolina**

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### **Climate Trends for the Area within Park Boundaries**

- Average annual temperature increased at a rate of  $1.2 \pm 0.6^{\circ}\text{C}$  ( $2.2 \pm 1.1^{\circ}\text{F.}$ ) per century in the period 1950-2010 (Figure 1). The highest warming was in summer (June-August).
- Total annual precipitation increased slightly in the period 1950-2010 (Figure 2).
- If the world does not reduce emissions from power plants, cars, and deforestation by 40-70%, models project substantial warming and increases in precipitation (Table 1, Figure 3).
- Projections under the highest emissions scenario project up to 20 more days per year with a maximum temperature  $>35^{\circ}\text{C}$  ( $95^{\circ}\text{F.}$ ) and an increase in 20-year storms (a storm with more precipitation than any other storm in 20 years) to once every 5-6 years (Walsh et al. 2014).

### **Historical Impacts in the Region**

- Analyses of tidal gauge measurements around the world have detected a statistically significant rise in global sea level of  $19 \pm 2$  cm ( $7 \pm 1$  in.) from 1901 to 2010 with analyses of potential causal factors attributing the rise to human climate change (Church and White 2011, IPCC 2013). For more sea level information for the park, see NPS report from Maria Caffrey.
- Measurements of sea surface temperatures in the Atlantic Ocean and around the world have found warming of the top 75 m of ocean water at a rate of  $1.1 \pm 0.2^{\circ}\text{C}$  ( $2 \pm 0.4^{\circ}\text{F.}$ ) per century from 1971 to 2010 (IPCC 2013).
- Analyses of Audubon Christmas Bird Count data across the United States, including counts in North Carolina, detected a northward shift of winter ranges of a set of 254 bird species at an average rate of  $0.5 \pm 0.3$  km per year from 1975 to 2004, attributable to human climate change and not other factors (La Sorte and Thompson 2007).

### **Future Vulnerabilities in the Region**

- If the world does not reduce emissions from power plants, cars, and deforestation, climate change could continue to raise sea level globally 26-55 cm (10-22 inches) by 2100 for the lowest emissions scenario (RCP2.6) and 52-98 cm (20-39 inches) for the highest scenario (RCP8.5) (IPCC 2013). Storm surge would occur over and above the projected sea level rise,

with models projecting more frequent and intense coastal flooding. For more sea level information for the park, see NPS report from Maria Caffrey.

- General circulation models project increases of ocean temperatures of 0.7°C under low emissions by 2035 (IPCC 2013).

**Table 1.** Historical rates of change per century and projected future changes in annual average temperature and annual total precipitation (data Daly et al. 2008, IPCC 2013; analysis Wang et al. in preparation). The table gives the historical rate of change per century calculated from data for the period 1950-2010. Because a rate of change per century is given, the absolute change for the 1950-2010 period will be approximately 60% of that rate. For the projections, note that under RCP6.0, temperature ramps up more slowly than under RCP4.5, but eventually overtakes the low scenario after mid-century. This is a property of how the emissions scenarios are written, with population and energy hitting their peak earlier, but at an eventually more sustainable level in RCP4.5. The table gives central values for the park as a whole. Figures 1-3 show the uncertainties.

|                                          | 1950-2010                       | 2000-2050        | 2000-2100        |
|------------------------------------------|---------------------------------|------------------|------------------|
| <b>Historical</b>                        |                                 |                  |                  |
| temperature                              | +1.2°C/century (2.2°F./century) |                  |                  |
| precipitation                            | +8%/century                     |                  |                  |
| <b>Projected (compared to 1971-2000)</b> |                                 |                  |                  |
| Reduced emissions (IPCC RCP2.6)          |                                 |                  |                  |
| temperature                              |                                 | +1.4°C (+2.5°F.) | +1.3°C (+2.3°F.) |
| precipitation                            |                                 | +6%              | +5%              |
| Low emissions (IPCC RCP4.5)              |                                 |                  |                  |
| temperature                              |                                 | +1.7°C (+3.1°F.) | +2.2°C (+4°F.)   |
| precipitation                            |                                 | +6%              | +6%              |
| High emissions (IPCC RCP6.0)             |                                 |                  |                  |
| temperature                              |                                 | +1.5°C (+2.7°F.) | +2.5°C (+4.5°F.) |
| precipitation                            |                                 | +6%              | +7%              |
| Highest emissions (IPCC RCP8.5)          |                                 |                  |                  |
| temperature                              |                                 | +2.2°C (+4°F.)   | +3.9°C (+7°F.)   |
| precipitation                            |                                 | +5%              | +7%              |

**Figure 1.** Historical annual average temperature for the area within park boundaries. Note that the U.S. weather station network was more stable for the period starting 1950 than for the period starting 1895. (Data: National Oceanic and Atmospheric Administration, Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

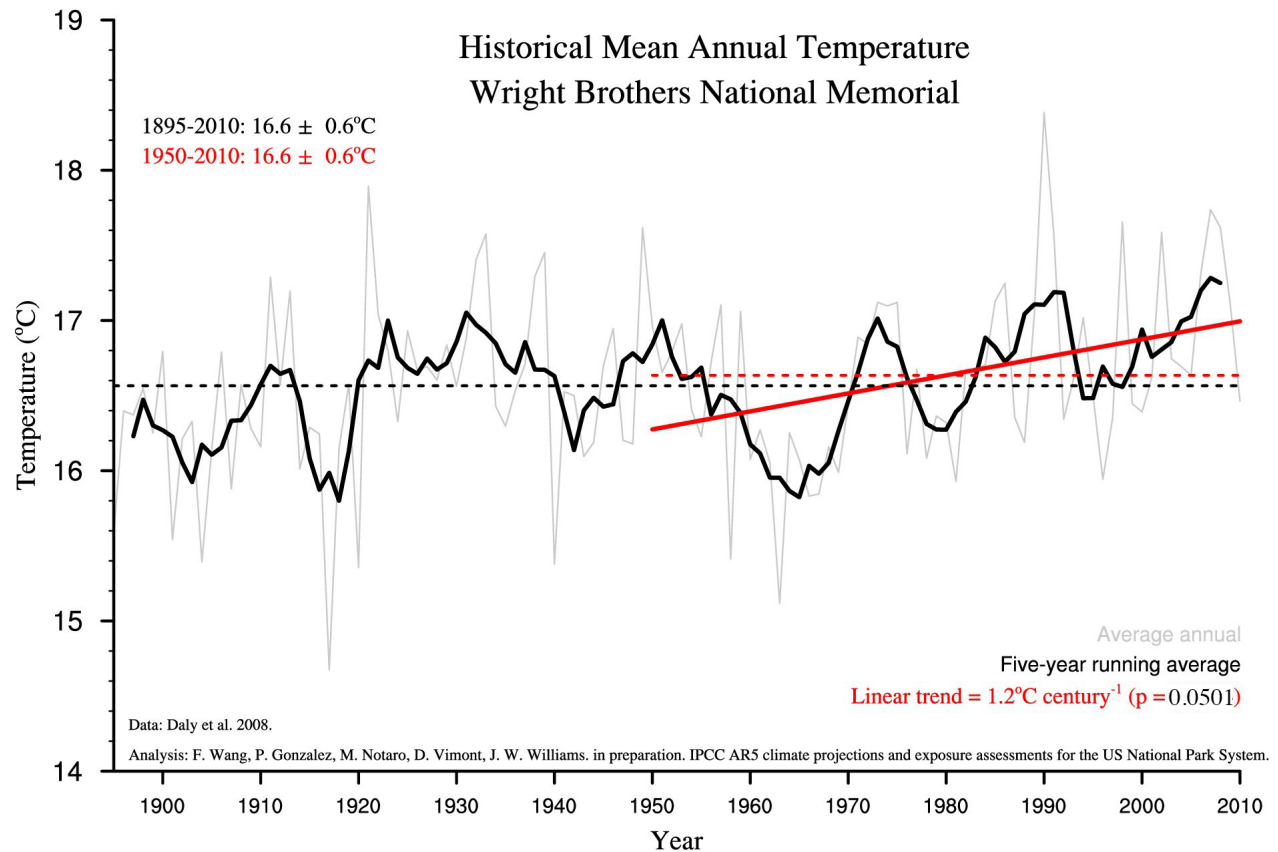


**Figure 2.** Historical annual total precipitation for the area within park boundaries. Note that the U.S. weather station network was more stable for the period starting 1950 than for the period starting 1895. (Data: National Oceanic and Atmospheric Administration, Daly et al. 2008. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

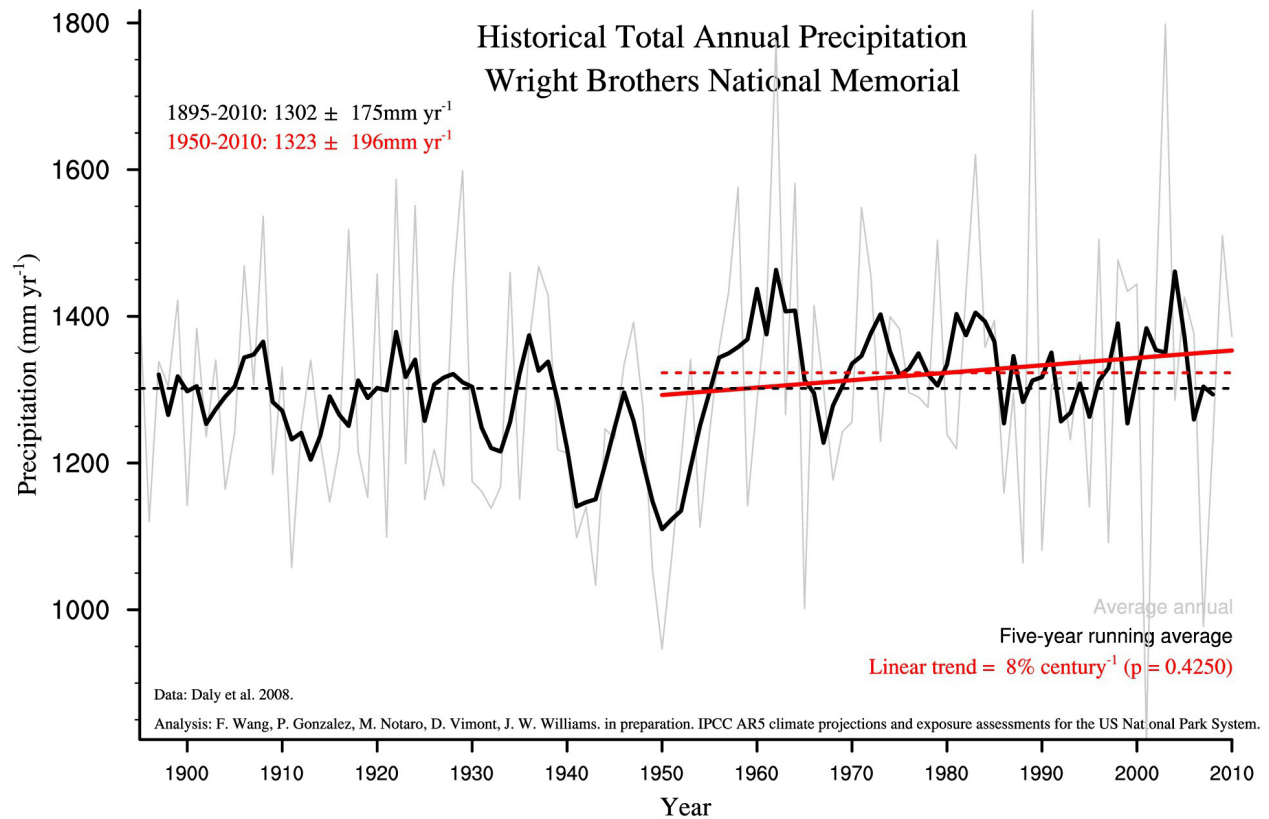
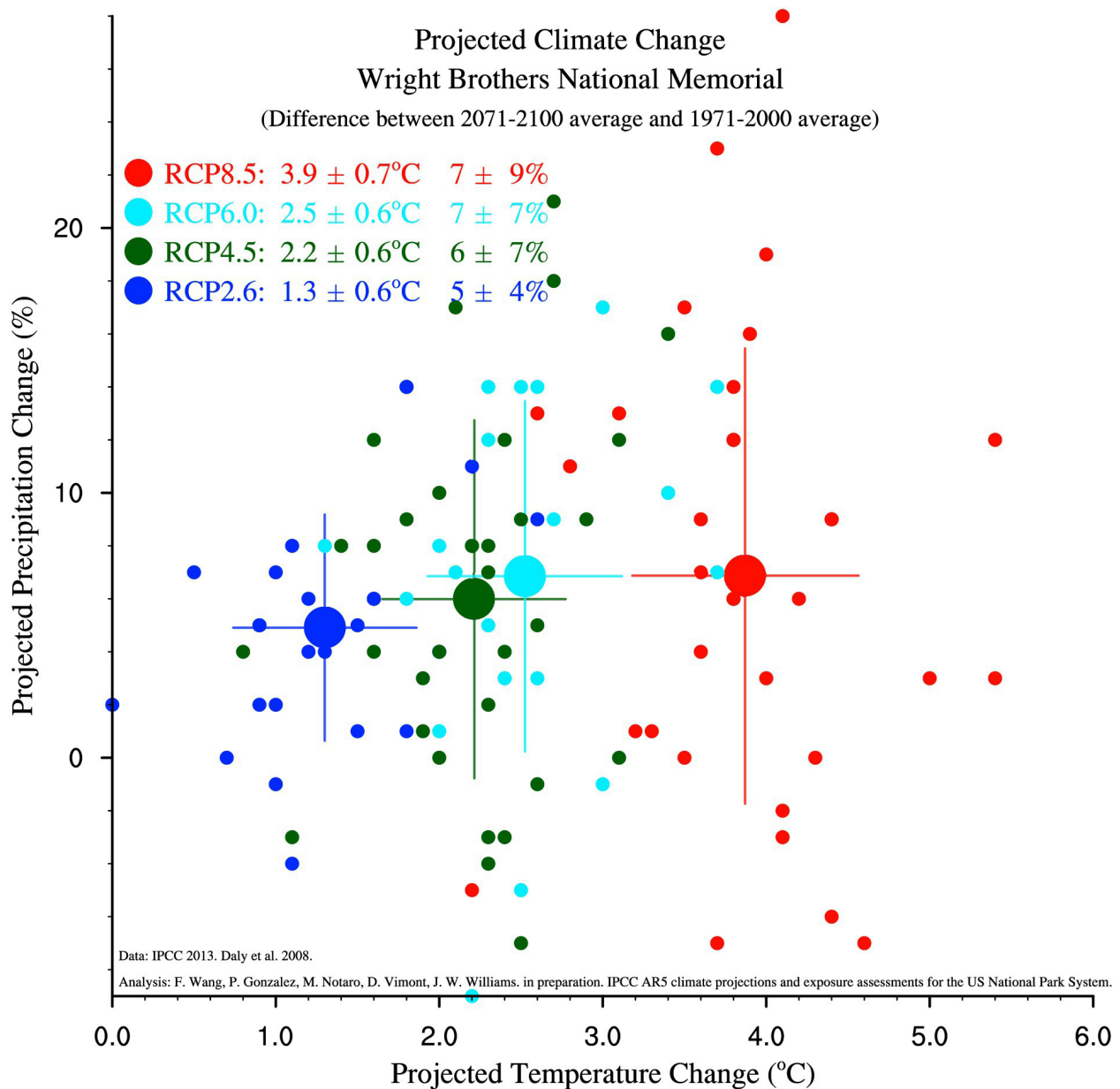


**Figure 3.** Projections of future climate for the area within park boundaries. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value. (Data: IPCC 2013, Daly et al. 2008; Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).



## References

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