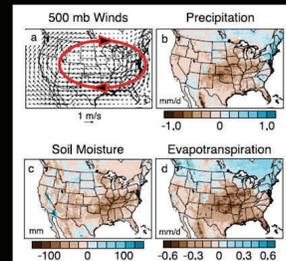
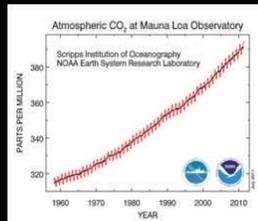
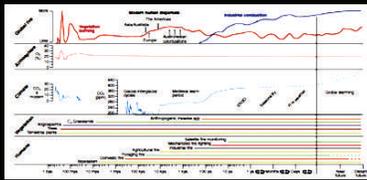
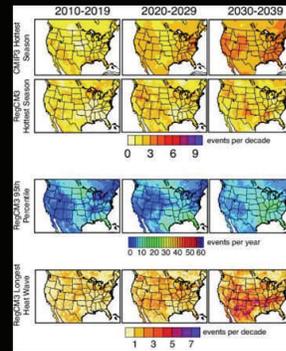
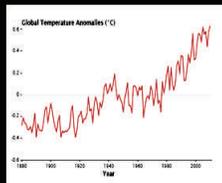
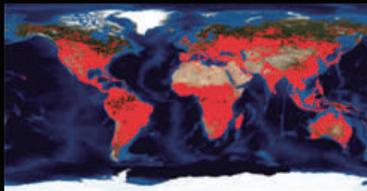




Synthesis of Knowledge: Fire History and Climate Change

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Abstract

This report synthesizes available fire history and climate change scientific knowledge to aid managers with fire decisions in the face of ongoing 21st Century climate change. Fire history and climate change (FHCC) have been ongoing for over 400 million years of Earth history, but increasing human influences during the Holocene epoch have changed both climate and fire regimes. We describe basic concepts of climate science and explain the causes of accelerating 21st Century climate change. Fire regimes and ecosystem classifications serve to unify ecological and climate factors influencing fire, and are useful for applying fire history and climate change information to specific ecosystems. Variable and changing patterns of climate-fire interaction occur over different time and space scales that shape use of FHCC knowledge. Ecosystem differences in fire regimes, climate change and available fire history mean that using an ecosystem specific view will be beneficial when applying FHCC knowledge.

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Cover Page Image Sources		
Source: Flannigan et al. 2009 Fig. 2. MODIS active fire detections for 2007	Global Temperature Anomalies 1880-2010. Source: NASA GISS	Source: Diffenbaugh & Ashfaq 2010 Figure 2.14a: Projected changes in heat extremes in the coming decades
Source: Bowman et al. 2009 (AAAS) Fig. 1. Qualitative schematic of global fire activity through time.		Source: Diffenbaugh & Ashfaq 2010 Figure 2.14b: Changes in summer (a) 500 mb winds, (b) precipitation, (c) total soil moisture, and (d) evapotranspiration
LANDFIRE: Fire Regime Condition Class (provided by Brian Tolk)	Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii. Source: NOAA ESRL	

Preface

Fire is a climate influenced ecosystem process recorded in paleoclimate and paleoecology records covering a long span of Earth history. Human use and management of fire increased human influence as climate warmed and modern societies emerged from the last ice age into the modern era. Modern fire management practices developed over the last century during relatively stable climate. As we entered the 21st Century, scientific evidenced mounted that human activities are now influencing climate to a significant extent. This report synthesizes available scientific information on fire history and climate change to describe likely impacts of 21st Century climate change on fire management. We accompany the report with an online bibliographic database found at:

https://www.zotero.org/groups/jfsp_fire_history_and_climate_change/items/order/creator

Fires are local events, with regional scale characteristics, governed by global scale climate patterns. Fire functions in an interactive zone of the Earth's atmosphere and vegetated landscapes (fuels). Fire modifies the atmosphere and influences ecosystem structure and function. Fire has played this role in Earth history for ~ 420 million years. Climate varied and changed during that time, affecting ecosystems, fire and their interaction. As climate warmed from ice age conditions in the last 10,000 years, human influence from land use change, agriculture and industrialization has increased. Humans have modified fire regimes and are modifying climate. Fire history records how climate, humans and other factors have shaped fire regimes in the past and help us understand how changing climate may modify fire regimes in the future.

Climate in the 21st Century will differ significantly from the 20th Century climate under which modern fire management developed. The magnitude and speed of projected 21st Century change will strongly influence ecosystem characteristics and fire regimes. Observed climate change is already affecting fire. Continuing increases in greenhouse gas (GHG) emissions will accelerate climate change and fire impacts. Managers are required to include climate change in their fire planning and to include consequences of changing fire regimes in strategic natural resources planning. This synthesis report will help managers plan for fire under changing climate.

The available body of relevant information is expanding rapidly, in articles that directly address fire history and climate, and in the broader arenas of climate and ecosystem science that are necessary to support the fire context. More than 40% of the over 1,000 references cited in the bibliography that accompanies this report were published in 2010 and 2011. This flow of supporting science will continue to provide managers with an unprecedented volume of science to inform their decisions. Improved understanding of fire history under past variable and changing climate will in turn improve our planning for fire during 21st Century climate change.

While empirical measures of weather, ignition and fuels will change as climate changes, the fundamental fire combustion process will function largely as it has through Earth history. 21st Century climate change is modifying the envelope within which managers conduct fire business, but not the business itself. Fire regimes will change, fire seasons will be longer, peak season periods of heat and drought will amplify, fuel conditions and ignition patterns will change in varying ways. Perhaps of greatest impact, the role of fire will become even more important in natural resource management as climate change mitigation and adaptation responses count on the benefits of carbon sequestration and ecosystem resiliency that fire can rapidly alter.

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