Paleofires and Models Illuminate Future Fire Scenarios

Advances in Interdisciplinary Paleofire Research: Data and Model Comparisons for the Past Millennium; Harvard Forest, Petersham, Massachusetts, 27 September to 2 October 2015

To what extent are current wildfires shaped by climate, vegetation, and human's influence on landscapes? Records of historic and older fires may shed light. Photo credit: Josh O'Connor, USFWS

By Ann Robertson, Esther Githumbi, and Daniele Colombaroli 13 April 2016

Thus, setting realistic restoration goals for forest management and conservation requires a historical baseline of fire under more "natural" conditions.

Fire regimes are shaped by biological, physical, and climatic processes that operate across decadal, centennial, and millennial timescales. These regimes have been modified by human land use for millennia. Thus, setting realistic restoration goals for forest management and conservation requires a historical baseline of fire under more "natural" conditions.

Regional to global syntheses of biomass burning through the Global Charcoal Database (http://www.paleofire.org) initiative show complex interactions between climate, vegetation, and fire. This complexity implies that the ways that fire regimes change in response to forecasted climatic changes may be difficult to predict, particularly across ecosystem and climatic boundaries.

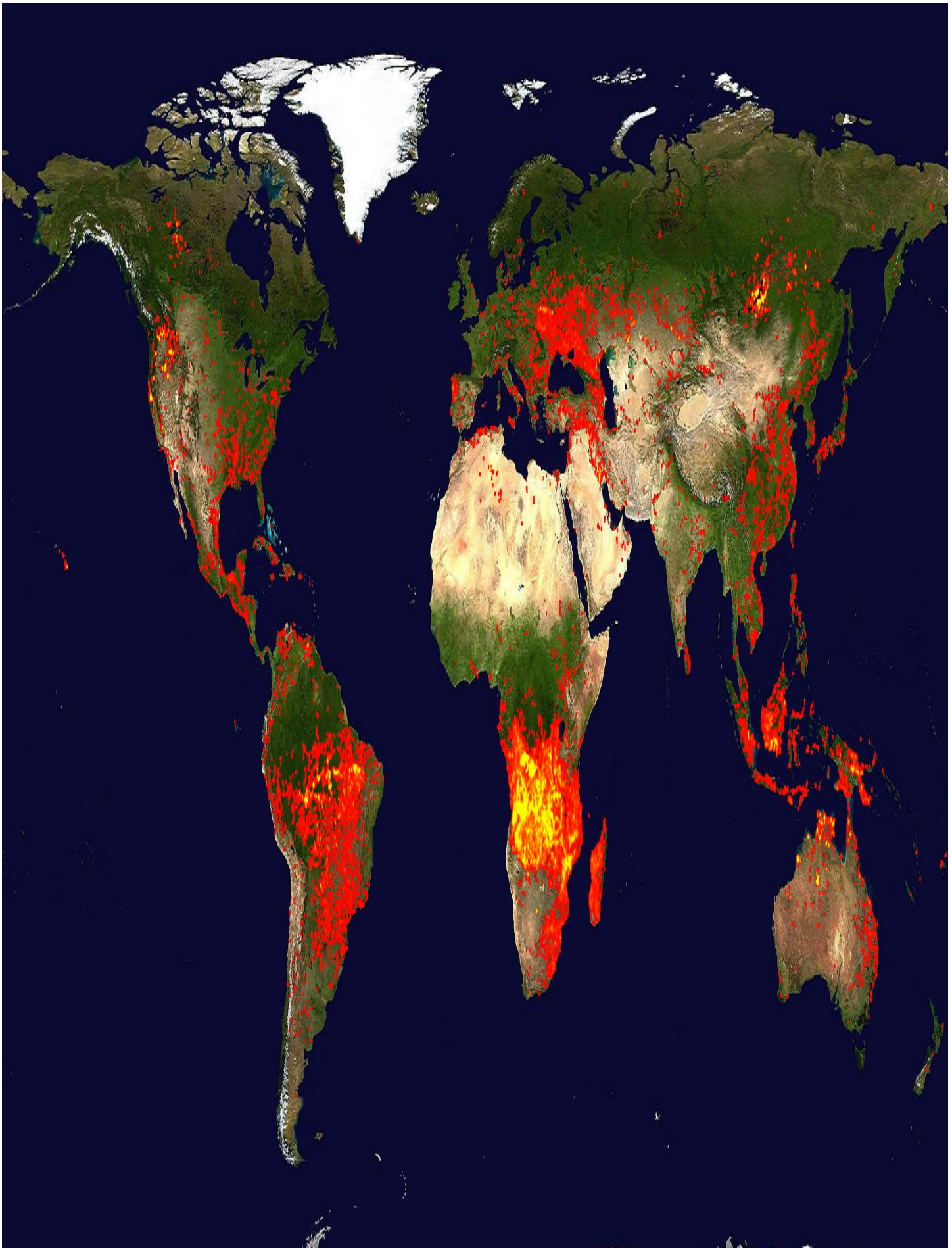
This fall, the Global Paleofire Working Group (GPWG), an international group of researchers who study fires recorded in the sedimentary record via charcoal particles, gathered to discuss technical and conceptual challenges (http://www.gpwg.paleofire.org/paleofire-data-model-comparisons-for-the-past-millenium) in reconstructing paleofires, new statistical approaches for reducing uncertainties in data and models, and interdisciplinary analyses of fire data from multiple archives (lake sediment, tree rings, and ice cores). These analyses rely on information from the Global Charcoal Database, GPWG's innovative database that uses multiple preserved physical records (proxies) that stand in for direct measurements of events in the distant past. Discussions focused on diverse topics, such as fire-vegetation interactions and the mechanisms governing extreme fire events.

Fire-vegetation feedbacks (in which vegetation fuels fires, and fires assist some types of vegetation) are important determinants of biome (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1693431/) distributions, but their role in mediating vegetation changes, as observed in the paleorecord, is poorly understood. Workshop participants designed an interdisciplinary approach combining modeling techniques with paleodata (e.g., pollen and sediment charcoal) that will test the role of fire feedbacks in fire-prone ecosystems during past biome transitions.

Understanding determinants of severe fire events in the past is relevant for managing ecosystems in the future. A subgroup therefore designed a model-data approach to test whether the use of fire by ancient North Americans—for example, for hunting and harvesting—changed across regions and during key cultural phases. Past changes in fires during cultural transitions can therefore inform today's managers about the impacts of altered fire regimes on vegetation dynamics and the relative roles of climate and humans in shaping fire-affected landscapes.

Workshop attendees also identified data-model comparisons that will help researchers assess

the climatic controls over “megafires.” Researchers’ efforts to combine models and data at different spatial and temporal scales will require filling gaps in key areas where charcoal data are presently scarce, such as Africa and Eurasia, which is now a top priority for the GPWG.



Red and yellow dots indicate fire activity observed by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) in fall 2010. Paleofire records can provide information about natural fire regimes before land use intensification and the extent to which humans shaped present ecosystems and modern fire regimes. Credit: NASA/EOSDIS, FIRMS (https://lance.modaps.eosdis.nasa.gov/cgi-bin/imagery/firemaps.cgi)

To address the scarcity of calibration studies in many areas of the world, attendees developed both empirical and process-based approaches to relate quantitative charcoal measurements to physical fire regime properties. For example, modern surface samples coupled with satellite data of known areas of burning (see Figure 1) will help constrain source areas of charcoal and link them to the distribution of charcoal particles across landscapes, so that scientists can learn about the processes that control where charcoal particles actually end up. Meanwhile, young researchers will lead a project—one of many interdisciplinary efforts that emerged from discussions at the workshop—to refine data collection protocols to allow data comparisons at global scales.

Workshop attendees agreed that future studies must emphasize data calibration, modeling, and new proxies to tackle long-standing challenges for paleofire researchers, such as refining the timing and extent of anthropogenic fire across ecosystems and biomes. The GPWG will continue to strengthen interdisciplinary approaches and foster cooperation between researchers, land managers, and stakeholders interested in the climatic, land use, and biodiversity impacts of fire. As the Global Charcoal Database grows beyond its current 700 records, new analyses and integrative data-model studies will become possible.

GPWG is supported by the U.S. and Swiss National Science Foundations (NSF) through Past Global Changes (PAGES). NSF grant BCS-1437074 supported the workshop.

—Ann Robertson, Yale Program on Climate Change Communication, Yale University, New Haven, Conn.; email: ann.robertson@yale.edu (mailto:ann.robertson@yale.edu); Esther Githumbi, York Institute for Tropical Ecosystems, Environment Department, University of York, Heslington, York, U.K.; and Daniele Colombaroli, Oeschger Centre for Climate Change Research and Institute of Plant Sciences, University of Bern, Bern, Switzerland

Citation: Robertson, A., E. Githumbi, and D. Colombaroli (2016), Paleofires and models illuminate future fire scenarios, *Eos, 97,* doi:10.1029/2016EO049933. Published on 13 April 2016.

© 2016. The authors. CC BY-NC 3.0