Greenhouse Gas Emissions from Wildland Fires: Toward Improved Monitoring, Modeling, and Management--A Workshop

September 13–15, 2023

Contents

NATIONAL ACADEMIES *Sciences*
Engineering
Medicine

Greenhouse Gas Emissions from Wildland Fires

Toward Improved Monitoring, Modeling, and Management—A Workshop

SEPTEMBER 13-15, 2023

VIRTUAL | KECK CENTER (500 5th St. NW Washington DC, 20001)

Additional information available on the _event page_

This workshop will address greenhouse gas emissions (GHG) from wildland fires, with goals of improving measurements and model projections of emissions, informing management practices that could limit emissions, and considering how changes in these emissions could affect the ability to achieve 'net-zero' GHG emissions targets. In particular, the workshop will consider the likelihood of increasing frequency of megafires in remote regions, where management actions are typically limited, and the potential for these regions to be large GHG emissions sources.

WEDNESDAY, SEPTEMBER 13, 2023 | All times ET

Current Understanding of Biomes Vulnerable to Wildland Fires and Implications for GHG Emissions

10:30–10:40   **Welcome and Opening Remarks**

Loretta Mickley, Harvard University, Committee Chair

10:40–10:50   **Opening Remarks**

Ann Bartuska and **Steve Hamburg**, Environmental Defense Fund

10:50–11:45   **Session 1: Framing the Workshop and Charge to Participants**

Moderators: Don Hankins, CSU Chico, & Loretta Mickley, Harvard University, Planning Committee Members

18 minute talks + 15 minutes Q&A

- **Nancy French**, Michigan Technological University, _Planning Committee Member_
- **Scott Stephens**, UC Berkeley

11:45–12:45   **Session 2: Roles of Fire in Presently Vulnerable Biomes and the Associated Net GHG Emissions**

Moderators: Nancy French, Michigan Technological University, & Loretta Mickley, Harvard University, Planning Committee Members

15 minute talks + 15 minutes Q&A

- **Hélène Genet**, University of Alaska Fairbanks
- **Matt Hurteau**, University of New Mexico
- **Susan Page**, University of Leicester and **Tom Smith**, London School of Economics

12:45–13:30   **Lunch**

13:30–14:20   **Session 3: Management of Fires and Ecosystems and Implications for GHG Emissions: Recent Past and Current**

Moderators: Don Hankins, CSU Chico, & Nancy French, Michigan Technological University,

Planning Committee Members

5 minute lightning talks + 20 mins Q&A/discussion

- **Amy Cardinal Christianson**, Canadian Forest Service
- **Dan Thompson**, Canadian Forest Service
- **Hugh Safford**, UC Davis
- **Karin Riley**, US Forest Service
- **Bibiana Bilbao**, Universidad Simón Bolívar
- **Cynthia Fowler**, Wofford College

14:20–14:30   **Instructions for Breakout Discussions**

14:30–14:45   **Break**

14:45–15:25   **Session 4: Breakout Discussions**

Participants join assigned in-person or virtual breakout rooms

Discussion moderators: **Sara Ohrel**, EPA; **Carly Phillips**, Union of Concerned Scientists; **Cynthia Whaley**, Environment and Climate Change Canada; **Ane Alencar**, Amazon Environmental Research Institute; **Joanne Hall**, University of Maryland; **Tatiana Loboda**, University of Maryland; **Adam Moreno**, CARB; **Douglas Morton**, NASA

Discussion questions:

- Which biomes and ecosystems merit the closest attention as climate changes and fire activity increases in some regions of the world? Has the workshop so far overlooked some vulnerable biomes/ecosystems?
- Are there scalable and sustainable methods of land management that have not yet been discussed?
- What uncertainties in fire activity or the carbon budget would be good to pin down? What are the major gaps in our knowledge of GHG emissions from fire that have not yet come to light?
- What synergies and differences are there from biome to biome regarding GHG emissions? What lessons can we transfer from one region to another?

15:25–15:55   **Report Back to Plenary**

5 minute transition back to plenary

Breakout moderators report back on key takeaways from their discussions

15:55–16:00   **Wrap Up and Plans for Day 2**

16:00   **END OF DAY 1**

THURSDAY, SEPTEMBER 14, 2023 | All times ET

Observations and Modeling Needs and Opportunities

10:30–10:40　**Welcome and Opening Remarks**

Loretta Mickley, Harvard University, Committee Chair

10:40–10:50　**Recap from Day 1**

Loretta Mickley, **Nancy French**, **Don Hankins**, Planning Committee Members

10:50–12:40　**Session 1: Observations of Wildland Fires and their GHG Emissions: Opportunities, Gaps, and Challenges**

Moderators: Chris (Fern) Ferner, Johns Hopkins University, & Amber Soja, NASA, Planning Committee Members

10 minute talks + 40 minutes Q&A/discussion

- **Andy Hudak**, US Forest Service
- **Jeff Vukovich**, US Environmental Protection Agency
- **Morgan Varner**, Tall Timbers
- **Martin Wooster**, King's College London
- **Bo Zheng**, Tsinghua University
- **Louis Giglio**, University of Maryland

12:40–13:25　**Lunch**

13:25–14:25　**Session 2: Defining the Future: Modeling Challenges and Defining the Largest Data Gaps— Fire Emissions Inventories and Future Projections**

Moderators: Amber Soja, NASA, & Jim Randerson, UC Irvine, Planning Committee Members

10 minute talks + 20 minutes Q&A/discussion

- **Stijn Hantson**, Universidad del Rosario, Bogotá
- **Park Williams**, UCLA
- **Matthew Jones**, University of East Anglia
- **Jed Kaplan**, University of Calgary

14:25–14:35　**Instructions for Breakout Discussions**

14:35–14:50　**Break**

14:50–15:30　**Session 3: Breakout Discussions**

Participants join assigned in-person or virtual breakout rooms

Discussion moderators:

Rebecca Scholten, Vrije Universiteit Amsterdam; **Carly Phillips**, Union of Concerned Scientists; **Cynthia Whaley**, Environment and Climate Change Canada; **Ane Alencar**, Amazon

Environmental Research Institute; **Joanne Hall**, University of Maryland; **Thomas Buchholz**, Spatial Informatics Group; **Tina Liu**, UC Irvine; **Douglas Morton**, NASA

Discussion questions:

- Identify the largest gaps in data, observations, and/or models that can inform what is needed to reduce uncertainties in carbon emissions to increase the potential for successful mitigation outcomes?

- What are the data gaps and model enhancements that need to be improved to predict the consequences of various proposed mitigation actions on estimates of future fire GHG emissions (e.g., prescribed fire vs wildfire over time)?

- What carbon stocks are most vulnerable to contemporary and future fire? Please consider the mass of potential loss and climate and socio-ecological impacts.

15:30–15:55   Report Back to Plenary

5 minute transition back to plenary

Breakout moderators report back on key takeaways from their discussions

15:55–16:00   Wrap Up and Plans for Day 3

16:00   END OF DAY 2

FRIDAY, SEPTEMBER 15, 2023 | All times ET

Future Management to Support Net Zero Targets

09:00–09:10   Welcome and Opening Remarks

Loretta Mickley, Harvard University, Committee Chair

09:10–09:20   Recap from Day 2

Chris (Fern) Ferner, **Jim Randerson**, **Amber Soja**, Planning Committee Members

09:20–10:10   Session 1, Part 1: Wildfire Emissions Impacts on National Reporting and Implications for Net Zero Targets

Moderators: Sally Archibald, University of Witwatersrand, & Brendan Rogers, Woodwell Climate Research Center, Planning Committee Members

10 minute talks + 20 mins discussion

- **Werner Kurz**, Canadian Forest Service
- **Grant Domke**, US Forest Service
- **David Bowman**, University of Tasmania

10:10–10:25   Break

10:25–11:40   **Session 1, Part 2: Opportunities for Solutions to Reduce Future Wildfire Emissions in Different Biomes**
10 minute talks + 25 mins discussion

- **Paul Hessburg**, US Forest Service
- **Peter Frumhoff**, Harvard University/Woodwell Climate Research Center
- **Susan Page**, University of Leiscester
- **Marcia Macedo**, Woodwell Climate Research Center
- **Geoff Cary**, Australian National University

11:40–11:50   **Instructions for Breakout Discussions**

11:50–12:35   **Lunch**

12:35–13:20   **Session 2: Breakout Discussions**
Participants self-select in-person or virtual breakout rooms

Discussion moderators: **Rebecca Scholten**, Vrije Universiteit Amsterdam; **Sara Ohrel**, EPA; **Gyami Shrestha**, Lynker Corporation; **Merritt Turetsky**, University of Colorado Boulder; **Tatiana Loboda**, University of Maryland; **Elizabeth Wiggins**, NASA; **Marisol Maddox**, Wilson Center

Discussion questions:

- What are climate effective, socially-inclusive, and ecologically-appropriate mitigation efforts to reduce future wildfire emissions?
- What are the barriers to implementation (trade-offs and co-benefits)?

13:20–13:35   **Break**

13:35–14:00   **Report Back to Plenary**
Breakout moderators report back on key takeaways from their discussions

14:00–15:15   **Session 3: The Solution Space and Next Steps: Forest Management of Tomorrow and Livable Emissions**
Moderators: Werner Kurz, Canadian Forest Service, & Brendan Rogers, Woodwell Climate Research Center, Planning Committee Members
Brief intros and moderated discussion

- **Paul Hessburg,** US Forest Service
- **Jimmy Fox,** US Fish and Wildlife Service
- **Dan Thompson,** Canadian Forest Service
- **Natasha Ribeiro**, University of Eduardo Mondlane College of Agriculture and Forestry, Maputo, Mozambique
- **Barry Hunter**, Aboriginal Carbon Foundation
- **Jayaprakash Murulitharan**, Cambridge University

15:15–15:25   **Day 3 Synthesis**
Sally Archibald, **Werner Kurz**, **Brendan Rogers**, Planning Committee Members

15:25–15:30   **Closing Remarks**
Loretta Mickley, Harvard University, Committee Chair

15:30   **ADJOURN WORKSHOP**

Guidance for Asking Questions Via Slido

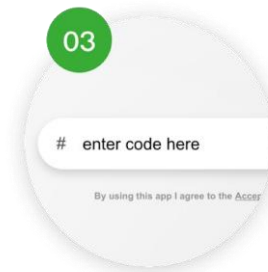**How to join the conversation**

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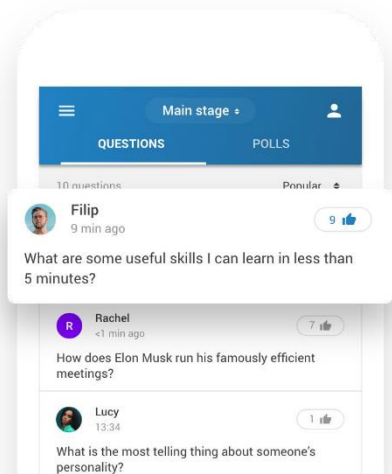Go to slido.com and enter the event code: **# GHGWildfires**

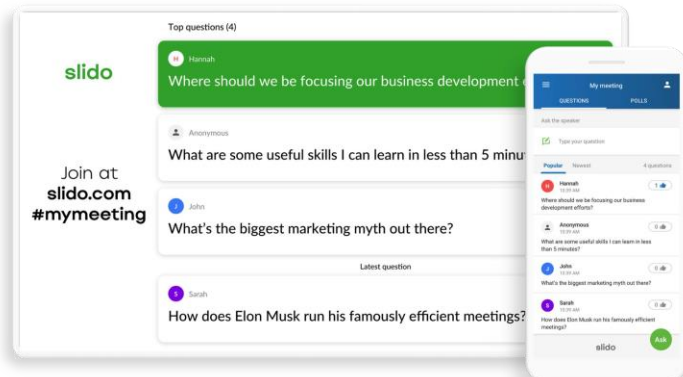Open browser   Go to slido.com   Enter event code: **GHGWildfires**

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Speaker Bios

Bibiana Bilbao, Professor at Environmental Studies, Simón Bolívar University, Venezuela, is a field fire ecologist with 25 years of teaching, researching, and capacity-building experience. She has promoted the integration of Indigenous, technical, and scientific knowledge into fire management policies in Venezuela and other Latin-American countries, fostering Indigenous Peoples and local communities' cultural heritage, biodiversity conservation and climate resilience. Europe Award 2010 Innovation for Sustainable Development and National Award 2013 for Best Scientific Work and Innovation. COBRA Collective (CIC), UK member, Co-founder of the South-American Participatory and Intercultural Fire Management Network, and Advisory Board member of the International Leverhulme Centre for Wildfires, Environment and Society, UK. She contributed to international organisations' reports (e.g., UNEP, LINKS-UNESCO, and RIOCC), about the value of fire culture Indigenous revitalisation in reducing wildfire risks. Recently, Bibiana completed the "Scientifique Invite" position at the 2022-2023 Programme at Montpellier Advanced Knowledge Institute on Transitions (MAK'IT), Montpellier University, France.

David Bowman is a Professor, Australian Research Council Laureate Fellow, and the Director of the transdisciplinary Fire Centre at the University of Tasmania, where he holds a research chair in Pyrogeography and Fire Science. He is recognized as a thought leader in wildfire science and management publishing influential research in high-impact journals, providing policy advice to government, and serving as an expert media commentor. Since 2019 he has been listed as a Clarivate highly cited cross-disciplinary Researcher.

Geoff Cary's research interests include landscape-scale simulation of fire management and climate change effects on fire regimes, fire ecology from genes to communities, house loss in wildland fire, and laboratory experimentation of fire behavior. He co-led an international group of landscape-scale wildland fire simulation modelers. Geoff teaches bushfire dynamics and management in courses including 'Fire in the Environment' (Convenor), with contributions to: 'Climate Change Vulnerability & Adaptation'; 'Biodiversity Conservation'; 'Environmental Policy'; and 'Island Sustainable Development'. Geoff is Associate Director (Research) in the Fenner School of Environment & Society at The Australian National University and was previously Associate Director (Higher Degree Research). He sits on the Editorial Advisory Committee, and is an Associate Editor, for the *International Journal of Wildland Fire*. He was previously a member of the New South Wales Parks & Wildlife Advisory Council, and the Bushfire Science Roundtable hosted by the Minister for Industry, Science and Technology.

Amy Cardinal Christianson is Métis and grew up in Treaty 8 territory (northern Alberta, Canada). Her Métis relations are the Cardinal (Peeaysis Band) and Laboucane (Laboucane Settlement) families. She currently lives near Rocky Mountain House in Treaty 6 (central Alberta). Amy is a Research Scientist with the Canadian Forest Service (Natural Resources Canada) and is currently on interchange to Parks Canada as an Indigenous Fire Specialist in the National Fire Management Division. Amy works with Indigenous Nations across Canada on fire stewardship practices like cultural burning and collaborates with Indigenous peoples from around the world on decolonising land management. She also studies wildfire evacuations and advocates for Indigenous wildland firefighters. She is the co-author of the books, First Nations Wildfire Evacuations: A guide for communities and external agencies and Blazing the Trail: Celebrating Indigenous Fire Stewardship. Amy cohosts the Good Fire podcast, which looks at Indigenous fire use around the world. She is a board member for the International Association of Wildland Fire and a member of the International Research Advisory Panel for Natural Hazards Research Australia.

Grant Domke is a Research Scientist and leads the Carbon Science Group in the Forest Inventory and Analysis Program within the United States Department of Agriculture Forest Service. Domke studies how carbon cycles through forest ecosystems in the U.S. using strategic-level forest inventory data and auxiliary

information. He leads the team responsible for compiling estimates of the land base and greenhouse gas emissions and removals in forests, woodlands, and harvested wood products each year as part of the United States' commitment to the United Nations Framework Convention on Climate Change. Domke has also served as a lead author on the Fifth National Climate Assessment, the Second State of the Carbon Cycle Report, and the Intergovernmental Panel on Climate Change guidelines for national greenhouse gas inventories.

Cynthia Fowler is Chair of the Sociology and Anthropology Department at Wofford College. Fowler's main research concerns are with the biosocial dynamics in fire environments and aquatic ecosystems. She has conducted ethnographic fieldwork in Indonesia, Hawai'i, Vietnam, the U.S. South, and Brazil. Fowler's three books demonstrate her interests in the human dimensions of fire and water: Fire Otherwise: Ethnobiology of Burning for a Changing World (2018, co-edited with Dr. James Welch), Biosocial Synchrony on Sumba: Multispecies Interactions and Environmental Variations in Indonesia (2016), and Ignition Stories: Indigenous Fire Ecology in the Indo-Australian Monsoon Zone (2013). On the topic of fire, recent journal articles by Fowler are "Pyrosociality: The Power of Fire in Transforming the Blue Ridge Mountain Ecoregion" (expected for release in *Environment and Society*, September 2023); "Prescribed Fire Use Among Black Landowners in the Red Hills Region, USA" (with the lead author Perkins together with Coates, Hiers, and Bigelow in *Ethnobiology Letters*, 2023); and "The Goodfire Campaign: Swaying Opinions About Prescribed Burning While Restoring Fire Adapted Ecosystems in the Southern Blue Ridge Mountains" (*Hotspots Fieldsites*, 2021). Fowler is co-editor of the monograph series *Global Change/Global Health* published by the University of Arizona Press as well as the *Contributions in Ethnobiology* monograph series published by the Society of Ethnobiology. In the public policy realm, Fowler is a Commissioner for the Fire and Rescue Advisory Commission for Polk County, North Carolina.

Jimmy Fox spent most of his youth exploring the hills and swamps of southeast Missouri – the ancestral lands of the Chickasaw and Osage peoples. He graduated from Southeast Missouri State University with a degree in wildlife management with a focus on restoring drained wetlands for waterbirds. He serves as the manager of Yukon Flats National Wildlife Refuge in east-central Alaska – a job I've held since 2019. It's hard for him to believe that his career in conservation spans over 30 years. HIs aspiration is to conserve their home by making progress on the adaptive challenges they face. He has dedicated the last four years to exploring how to respond to rapid environmental change on a vast, roadless landscape in a time of declining organizational capacity. To engage in this work with others at this moment in time is simultaneously an incredible honor and a terrifying realization.

Peter Frumhoff teaches environmental science and public policy at Harvard University and is the senior science policy advisor at the Woodwell Climate Research Center. A global change ecologist, his research extends from the role of forests in climate mitigation to the climate responsibilities of fossil fuel companies to the responsible governance of solar geoengineering research. Dr. Frumhoff served through2023 on the Board of Atmospheric Sciences and Climate at the National Academies of Sciences, Engineering and Medicine. He is a Fellow of the American Association for the Advancement of Science and the 2022 Richman Distinguished Fellow in Public Life at Brandeis University. Through 2021, he was the longtime director of science and policy and chief climate scientist at the Union of Concerned Scientists. There, he led strategies and initiatives to bring robust climate science to bear on informing public understanding and motivating public policies; guided science, equity, and innovation post-doctoral fellowships; and served as senior liaison with the scientific community, policymakers, funders and the media. He was a lead author of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which was awarded the Nobel Peace Prize in 2007, and lead author of the IPCC Special Report on Land Use, Land-use Change and Forestry. He has guided multiple regional climate impacts assessments, including the 2007 Northeast Climate Impacts Assessment. Dr. Frumhoff has taught at Stanford University, the Fletcher School of Law and Diplomacy at Tufts University and the University of Maryland. He was a AAAS Science and Diplomacy Fellow at the US Agency for International Development. He received a PhD in ecology and an MA in zoology from the University of California, Davis, and

a BA in psychology magna cum laude from the University of California, San Diego

Hélène Genet is an Associate Professor at the Institute of Arctic Biology of the University of Alaska Fairbanks. Her educational background is focused on forest science and plant ecophysiology. She is a terrestrial ecologist and have been studying high latitude ecosystems for the past 14 years. She is using field observations, and remote sensing data to inform ecosystem models to study how past and future climate change, and disturbances impact permafrost, land cover and the carbon dynamics at local and regional scales. Her research is particularly focusing on the effects of warming and changes in precipitation regime on wildfire risks and permafrost thaw and their implications on land cover dynamic, hydrology, and the release of greenhouse gases (carbon dioxide and methane).

Louis Giglio is a Research Professor in the Department of Geographical Sciences at the University of Maryland, College Park. Dr. Giglio is the Principal Investigator for NASA's MODIS and VIIRS active fire and burned area product suites and is now leading a new effort to develop a consistent and continuous satellite-based global fire record extending back to the late 1970s. His research interests include remote sensing of active fires and burned area on a global scale, global fire emissions, and product uncertainty analysis. Prior to his academic appointment, Dr. Giglio was a research scientist with Science Systems and Applications, Inc., at NASA's Goddard Space Flight Center. He received a B.S. in Physics from the University of Maryland, an M.S. in Applied Physics from The Johns Hopkins University, and a Ph.D. in Geography, again from the University of Maryland.

Stijn Hantson is a dedicated forest ecologist whose research expertise centers around remote sensing, tropical fire ecology, and global fire-vegetation modeling. In his current role as an Associate Professor at Universidad del Rosario (Colombia), he primarily focuses on advancing our understanding of tropical fire ecology and its pivotal role in shaping the global carbon cycle. His research tries to integrate ecological insights with GIS, remote sensing technologies, and global fire-vegetation modeling. Furthermore, he is one of the coordinators of the Fire Model Intercomparison Project (FireMIP) which aims to understand present-day fire impact on the earth system, and how future fire dynamics will be influenced by climate and socioeconomic changes. His studies of forest and nature conservation at Wageningen University (BSc & MSc) and remote sensing at Universidad de Alcala (MSc & Phd) prepared him to have a multidisciplinary scientific career.

Paul Hessburg is Senior Research Ecologist with USDA-Forest Service R&D, USDA Distinguished Scientist, Distinguished Landscape Ecologist with the International Association for Landscape Ecology -- North America, and affiliate Professor, University of Washington, Oregon State University, Washington State University, and the University of British Columbia. He is also the current President of the International Association for Fire Ecology (AFE). His research explores wildfire and climate change influences on landscape dynamics, the ecology of forest reburning, and the structure and organization of historical, current, and future landscape resilience. Paul has authored more than 230 original research articles and was invited to present a Ted Talk on the western US wildfire problem in 2017. You can follow his research here or here.

Andy Hudak got his Ph.D. in 1999 from the University of Colorado. From 1999-2001, he began working for the U.S. Forest Service as a postdoctoral Research Ecologist with the Pacific Northwest Research Station. Since 2001, he has worked as a Research Forester with the Rocky Mountain Research Station. He currently studies biophysical relationships between field and remotely sensed data, including estimating aboveground biomass carbon across the western U.S. from airborne lidar, Landsat time series, and other environmental data; predicting fuel/carbon loads from 3D point cloud metrics at multiple scales; and relating fuel consumption to energy flux and fire effects.

Barry Hunter is a descendant from the Djabugay speaking people of Cairns hinterland. He grew up besides the Barron River in the rainforest near Kuranda. Barry's experience includes employment in Government

conservation agencies, mining and exploration industry, community and not-for-profit NGOs, and recently as a consultant working around Aboriginal Land Management, Carbon Industry and community economic development. With over 30 years' experience in Aboriginal affairs particular in areas of land, natural and cultural resource management. Barry has a Bachelor of Applied Science from Charles Sturt University and has a keen interest in the work community rangers do in looking after land, fire management and cultural heritage. Also having a real passion building community capacity and planning that deliver sustainable social, cultural, and economic outcomes within our communities.

Matt Hurteau is a Professor of Quantitative Ecology in the Department of Biology at the University of New Mexico. His research focus is on understanding how climate change and disturbance alter the distribution of tree species and carbon dynamics across landscapes. He works extensively with land managers and policymakers at the local, state, and federal level to facilitate science informing decision-making.
http://www.hurteaulab.org/

Matthew Jones' research focuses on how climate change influences global and regional patterns of wildfire, and the consequences of wildfires for carbon budgets. Having secured over £1 million in fellowship and studentship grants since 2021, he now leads a growing 'Firecrew' group at the University of East Anglia. He enjoys passing his experience as an early career researcher on to the next generation of scientists. Alongside his research on fire, he proudly contributes to annual updates of the Global Carbon Budget – a key scientific report that reaches one-third of the world's population each year with information about humanity's impact on Earth's climate. Further, he has contributed in policy reports and workshops related to fire and the carbon cycle at the national and international level. With a track record of impactful publications and media appearances, he is passionate about bridging science and society to tackle urgent environmental challenges.

Jed Kaplan is Professor in the Department of Earth, Energy, and Environment, University of Calgary, and an editor-in-chief of *Global and Planetary Change*. Jed's current research interests center around the development and application of computer simulation models of vegetation dynamics, wildfire, and earth surface processes. He is particularly interested in human-environment interactions over the late Quaternary and understanding how human use of fire and other forms of land management interacted with climate in the past, and how these may be adapted to the present and future. His current research projects include characterization of wildfire fuels in subtropical forests and shrublands using portable LiDAR, development of next-generation vegetation models, modeling global and regional wildfire, global synthesis of lightning occurrence, paleoenvironmental reconstruction using pollen and charcoal data, and archaeological reconstruction of past land use systems in Southeast Asia and the Caucasus.

Marcia Macedo is an Ecosystem Ecologist studying the causes of tropical deforestation and forest degradation and their consequences for forests, rivers, and the climate. Her research explores how agricultural expansion and climate change are reshaping tropical landscapes by altering the hydrological cycle and regional fire dynamics. Macedo uses a combination of field observations, satellite data, and modeling to understand these processes, identify science-based solutions, and inform management interventions. Recent work has focused on translating this information for operational use by state and Indigenous fire brigades in the Brazilian Amazon and quantifying the exposure of rural populations to smoke from biomass burning and wildfires. Macedo is an Associate Scientist and Director of the Water Program at the Woodwell Climate Research Center. She earned a M.Sc. in Sustainable Development & Conservation Biology from the University of Maryland and a Ph.D. in Ecology, Evolution, & Environmental Biology from Columbia University.

Jayaprakash Murulitharan is a Ph.D. candidate at the University of Cambridge, UK, specializing in Atmospheric Science and focusing on transboundary haze pollution in the Greater Kuala Lumpur region. With 17 years of expertise as a Principal Assistant Secretary at Malaysia's Ministry of Environment and Climate Change, his experience includes domestic, regional, and international Environmental Management, especially

in air pollution policies. Jayaprakash's significant contributions include monitoring Malaysia's adherence to the Hydrofluorocarbon Phasing Out Programme (HPMP) under the Montreal Protocol Treaty and spearheading the Environmental Performance Index (EPI) development. He also played a pivotal role in establishing the National Environmental Quality Monitoring Programme (EQMP), the East Asia Acid Deposition Network (EANET), and contributing to the ASEAN Agreement on Transboundary Haze Pollution (AATHP). His dedication to mitigating haze pollution in the ASEAN region, primarily stemming from biomass burning, showcases his commitment to regional cooperation. As a Chevening Scholar, he earned a Master of Science in Sustainability and Environmental Studies at the University of Strathclyde, UK, complementing his academic foundation in Chemical Engineering from the University of Technology, Malaysia. Jayaprakash Murulitharan is a seasoned environmental professional and a dedicated researcher committed to safeguarding our environment from transboundary haze pollution, making a lasting impact in the field of Environmental Management.

Susan Page holds a personal chair in the School of Geography, Geology & the Environment at the University of Leicester, UK. For the last 30 years her research has focused on tropical and temperate peatland ecology and carbon dynamics, including investigation of the impacts of land use change and fire, opportunities for greenhouse gas emissions mitigation, and ecosystem restoration. She is a partner in peatland research programmes in the UK, Southeast Asia and the Congo Basin. Her interest in peatland fires started with the 1997/98 fire event in Indonesia, and has continued with a focus on fire use, emissions and suppression strategies. Professor Page was a Lead Author for the Intergovernmental Panel on Climate Change (2013 wetlands supplement) for which she brought together the limited amount of information, at that time, on emissions from burning organic soils.

Natasha Ribeiro was born and raised in Maputo, Mozambique on August 24th 1971. She holds a bachelors degree in Forest Engineering from the Eduardo Mondlane University (UEM) in Mozambique, a MSc. in Management and Conservation of Biodiversity from the Centro Agronomico Tropical de Investigación y Enseñanza (CATIE) in Costa Rica and a PhD in Environmental Sciences from the University of Virginia (UVa) in the USA. Natasha has more than 25 years of professional experience in teaching, researching and extension in fields of restoration ecology and forest fires. Her teaching experience includes national and international universities and coordination of academic development projects. In research, Natasha has initiated a long-term fire-related research program in the Niassa Special Reserve, one of the most important conservation areas in Mozambique, southern Africa. The program has helped defining conservation action in the country. Natasha has been appointed the coordinator of key missions in the country such as the National Strategy and Action Plan for Biodiversity Conservation (NBSAP) under the UN Convention on Biodiversity. She also serves as an advisor in several international forums such as the IUFRO Forest Fire taskforce and the European project, FirEURisk. Between 2011 and 2021 she was the regional coordinator of the Miombo Network of southern Africa. Natasha was the recipient of the 2017-2018 Fulbright Visiting Scholar Program grant, which she used to visit the University of Virginia. She coordinated the book "Miombo woodlands in a changing world: securing the resilience and sustainability of people and woodlands" which was published in 2020.

Karin Riley is a Research Ecologist with the US Forest Service, stationed at the Fire Sciences Lab in Missoula, Montana. Her research focuses on understanding climate effects on wildland fire, as well as modeling forests of the conterminous US with the goal of understanding carbon dynamics related to fire risk. She is the co-PI of the "Tradeoffs in Prescribed Fire Emissions" project funded by the Bipartisan Infrastructure Law. Riley serves on the Board of the Association for Fire Ecology and is Associate Editor of Fire Ecology. Riley earned an AB in Earth and Planetary Science from Harvard University, an MS in Environmental Systems from CalPoly Humboldt, and a PhD in Geology from the University of Montana.

Hugh Safford is Chief Scientist for Vibrant Planet, an environmental startup focused on biosphere resilience and wildfire risk mitigation, and a research ecologist at the University of California-Davis. Before joining Vibrant

Planet, Safford was Regional Ecologist for the USDA-Forest Service's Region 5 (California, Hawaii, Pacific territories) for more than two decades. Safford is Sierra Nevada section director of the California Fire Science Consortium, and he is PI of the California Prescribed Fire Monitoring Program (a partnership with CALFIRE). Safford has provided international technical assistance on fire, forest management, and climate change issues since the 1990s. Recent projects include fire risk mapping in Georgia, fire management planning in Mexico, climate change adaptation in Brazil, and forest restoration in the Levant. Safford studied post-fire ecosystem restoration practices in the Mediterranean Basin as a Fulbright Fellow between 2017 and 2019. He was co-editor of the 2021 *Postfire Restoration Framework for National Forests in California*, which provides guidance for management decision-making in burned ecosystems under changing environmental baselines.

Scott Stephens is a Professor of Fire Science at the University of California, Berkeley. He is interested in the interactions of wildland fire and ecosystems. This includes how prehistoric fires once interacted with ecosystems, how current wildland fires are affecting ecosystems, and how future fires and management will influence people and ecosystems. He is also interested in wildland fire and forest policy and how it can be improved to meet the challenges of the coming decades, both nationally and internationally. Working with Indigenous partners to learn how to steward ecosystems into the future with climate change is a key area of research. Stephens has given testimony on fire and forest policy at the US House of Representatives, the White House, California Assembly and Senate, California Governor's office, and is currently on the US Wildfire Commission created by the Biden Administration. He is one of the leaders of the Stewardship Project which is a partnership with Indigenous people to improve federal fire policy.

Dan Thompson has worked as a wildfire research scientist with the Canadian Forest Service since 2011. He graduated with a Ph.D. in forest hydrology from McMaster University in 2012. His research is focused primarily on boreal wildfire and its impacts using an environmental physics framework. He is a member of the Canadian Forest Service Fire Danger Rating Group that revises the Canadian Fire Weather Index and Fire Behaviour Prediction systems. Dr Thompson is the fire applications lead for the WildFireSat Canadian Operational Mission and a scientific contributor to Canada's smoke and air quality forecasting model, FireWork. Dr. Thompson is also a nationally-certified Fire Behaviour Analyst, where he provides projections of fire behaviour and spread to Incident Management Teams. Notable deployments include Fort McMurray 2016, British Columbia 2017 and 2021, and Alberta, Quebec, and the Northwest Territories in 2023.

Morgan Varner is Director of Research and Senior Scientist at Tall Timbers Research Station in Tallahassee, Florida. At Tall Timbers he leads a team of scientists working on improving the understanding of fire behavior, wildland fuels, and the ecological effects of fire. He has authored more than 140 peer-reviewed articles and book chapters on fire ecology and the impediments to prescribed fire use in North America. Before Tall Timbers, he led a USDA Forest Service R&D team in Seattle and was a professor of fire ecology at Virginia Tech, Mississippi State, and Humboldt State for 12 years. He is past Chairman of the Coalition of Prescribed Fire Councils. He received his BS from the University of Idaho, MS from Auburn University, and PhD from the University of Florida.

Jeff Vukovich is a Physical Scientist in the Emissions Inventory and Analysis Group at the Office of Air Quality Planning and Standards in Research Triangle Park, NC. He has been involved with the development and application of emissions inventories and modeling systems for about 30 years. He is currently the Emissions Inventory sector lead for wildland fires. Jeff has been leading EPA projects that produced emissions inventories for wildland fires for years 2016, 2018, 2019, 2020 and 2021. This includes the recent release of the 2020 National Emissions Inventory wildlands fire inventory.

Park Williams is a Hydroclimatologist whose research aims to understand the causes and consequences of hydrological extremes such as drought. Much of his research focuses on hydroclimatology in its own right, and much also aims to improve understanding of how hydrological extremes affect life on earth, such as the

impacts of drought and climate change on wildfire. Questions that he finds especially interesting involve the effects of human-caused climate change on the hydrological cycle, ecological systems, and humanity through extreme events such as heat waves, wildfires, and flooding.

Martin Wooster is an expert on satellite Earth observation and the quantification of landscape fire. He was appointed Professor of Earth Observation Science at King's in 2005. He joined the Department of Geography in 1998 on a lectureship funded by the Natural Environment Research Council (NERC) Earth Observation Science Initiative (one of four such lectureships awarded nationally in the UK). He is currently working on the Leverhulme Centre for Wildfires, Environment and Society, in partnership with Imperial College London, Royal Holloway and the University of Reading. Previously, he was the Principal Investigator in the NERC National Centre for Earth Observation. His research was instrumental in developing the operational Fire Radiative Power (FRP) product from the Meteosat Second Generation satellites, available free in real-time from the EUMETSAT Land Satellite Applications Facility (Land SAF). Martin chaired the Steering Committee of the NERC Field Spectroscopy Facility and was previously a member of the Steering Committee of the NERC Airborne Remote Sensing Facility. He holds investigatorships on a number of remote sensing missions.

Bo Zheng is an Assistant Professor at Tsinghua University in China. Bo specializes in mitigation and adaptation strategies for climate change and air pollution, with a focus on the quantitative assessment of carbon sources and sinks based on remote sensing techniques. Bo has developed a variety of atmospheric inversion tools to analyze air pollutant and greenhouse gas budgets, aiming to understand their spatiotemporal distribution patterns and driving factors. For wildland fires, Bo has developed a near-real-time atmospheric inversion system to monitor global wildfire CO_2 emissions by reconstructing the spatial-temporal dynamics of burning efficiency based on satellite CO retrieval data. Through using this system, Bo has characterized the spatial and temporal patterns of wildfire emissions since 2000 and identified the drivers behind the rising carbon emissions from the boreal wildfires, which reveals a positive feedback mechanism between climate warming and boreal wildfire emissions.

Moderator Bios

Ane Alencar is the Science Director at IPAM, a research based environmental Brazilian NGO working in the past 28 years to promote sustainability, healthier environment, and social justice in the Amazon. She is a Geographer with a Master degree in Remote Sensing and Geographic Information System from Boston University and PhD in Forest Resources and Conservation at the University of Florida. For the past three decades she has been working at IPAM with the spatial and ecological dynamics of rainforest understory fires and their relationship with deforestation, land use practices, and climate change. She is one of the lead authors of the Science Panel for the Amazon, and coordinates MapBiomas Fire, a comprehensive Brazil burned area monitoring initiative which uses deep learning. She also coordinates the Forest Fires GHG emissions estimate from SEEG, one of the most used GHG estimate database in Brazil.

Thomas Buchholz leads the Forest and Agriculture Team at SIG. Thomas has more than 16 years of experience in working with governments, academia, nonprofits and the private sector in forest management, economics as well as energy and carbon life cycle assessments (LCA) for of natural forests as well as timber and biomass plantations in the US, Europe and Sub-Saharan Africa. Thomas combines technical expertise on forest ecology, wildfire risk and behavior, remote sensing applications, ecosystem service markets (e.g., carbon offsets) and wood product markets to provide new forest management opportunities to clients. In this context, he has coordinated efforts to get a carbon accounting methodology 'Reduced Emissions from Megafires' (REM) endorsed by Climate Forward, a sub-platform of the Climate Action Registry. REM enables co-funding fuel treatments through the carbon market. Thomas has affiliations with the University of Montana, Strathmore University in Nairobi, Kenya, and the Gund Institute for Environment at the University of Vermont. He has been the lead author of numerous peer-reviewed science publications and technical reports on forest economics and forest-based bioenergy topics across the globe, ranging from carbon LCA's for wildfire-prone forests in the western US to bioenergy economics in East Africa. Thomas is based in Missoula, Montana.

Joanne Hall is an Assistant Research Professor in the Department of Geographical Sciences at the University of Maryland, College Park and the Program Coordinator for the NASA Applied Sciences Wildland Fires Program. She received her PhD in Geographical Sciences with an emphasis on Remote Sensing and Geographical Information Sciences from the University of Maryland. She also has two MSc Degrees, one in Atmospheric and Oceanic Science from the University of Maryland, and the other in Environmental Geoscience from the University of Bristol, U.K. Dr. Joanne Hall has over 10 years of graduate and post-graduate research and teaching experience. Her current research interests lie in the broad areas of satellite mapping of land-cover and land-use change, with a particular emphasis on active fire and burned area mapping. Specifically, her current research focuses on (1) the improvement of global cropland burned area and emission estimates using remote-sensing techniques, (2) the validation and harmonization of a multi-sensor geostationary active fire product, and (3) the overall optimization and improvement of the MODIS and VIIRS fire products. She is originally from South Africa, lived in England, and eventually settled in Maryland.

Tina Liu is currently a NOAA Climate & Global Change Postdoctoral Fellow at U.C. Irvine. She holds a PhD from Harvard University in Earth and Planetary Sciences and a BA from Columbia University in Environmental Science. Broadly, her research interweaves atmospheric chemistry, remote sensing / GIS, statistical modeling, and public health in an effort to better understand the (1) human and climate drivers and (2) air quality and public health impacts of global fires, with a special focus on India, Equatorial Asia, and the western United States. Currently, she uses geostationary satellite observations of active fires to map the hourly progression of wildfires in the western U.S. The resulting algorithm and database have broad applications for fire spread

modeling and atmospheric modeling of smoke.

Tatiana Loboda is an expert in Geospatial Data Science and works extensively with satellite observations and space-time modeling. Her research interests include wildland fire, biodiversity, climate change, public health and their interactions with other human and physical factors on the landscape. Her work incorporates satellite observations of land surface conditions and change to study a variety of science questions ranging from impacts of wildfire on ecosystems and climate to assessing the impacts of conservation policies on poor rural communities to forecasting malaria outbreaks in the tropics. Geographically, her research is mostly focused on boreal forest and tundra biomes, although she has also been involved in studies of temperate and tropical ecosystems. Dr. Loboda has been an investigator on numerous NASA and NIH projects covering basic and applied research. Most recently, Dr. Loboda has been developing remote sensing-data driven models and modeling chains to forecast risk of malaria outbreaks in Myanmar and assess impact of wildfire pollution on health outcomes of Alaskans.

Marisol Maddox is a Senior Arctic Analyst at the Polar Institute of the Woodrow Wilson International Center for Scholars. Her research considers the Arctic nexus of climate change, security, and geopolitics. She is particularly interested in how the growing presence of actorless threats-- such as climate change and biodiversity loss-- interplays with traditional security challenges and strategic thinking. Ms. Maddox currently serves as a core expert on the Arctic at the European Centre of Excellence for Countering Hybrid Threats. She is a non-resident research fellow at the Center for Climate & Security and a term member of the Council on Foreign Relations. She regularly teaches at the Ted Stevens Center for Arctic Security Studies and the Geneva Centre for Security Policy. She holds an M.A. in International Security with a concentration in Transnational Challenges from George Mason University's Schar School and a B.A. in Environmental Studies with a concentration in Ecosystems from SUNY Binghamton.

Adam Moreno is the California Air Resources Board's (CARB) lead natural and working lands climate scientist. He leads CARB's science and modeling to identify the role that all lands can play in the state's efforts in becoming carbon neutral. He most recently led the lands component of California's Scoping Plan, the state's road map to carbon neutrality. This work included developing the framework for incorporating wildfire emissions into the overall statewide carbon neutrality goals. Dr. Moreno also advises various other statewide efforts related to ecosystems and climate including serving on the governor's Wildfire and Forest Resilience Task Force science advisory panel. He was previously an earth scientist at NASA Ames, where he studied the climate change impact on North American forests. He has also been a Peace Corps volunteer in Paraguay, South America, and a wildland firefighter as a hotshot with the U.S. Forest service. He holds a bachelors in computer engineering, a masters in ecological modeling, and a doctorate in remote sensing and forest ecology.

Douglas Morton is an Earth system scientist and Chief of the Biospheric Sciences Laboratory at NASA's Goddard Space Flight Center. His research combines satellite data, models, and field measurements to understand fire impacts on ecosystems, communities, air quality, and climate. Dr. Morton has worked for more than 20 years in the Brazilian Amazon, where his research has captured the changing dynamics of fire activity associated with tropical deforestation, forest degradation, and agricultural management. He is also a member of the Global Fire Emissions Database (GFED) science team, and he leads the development of new instrument and mission concepts for global fire science at NASA.

Sara Bushey Ohrel has served the U.S. Environmental Protection Agency as an economist in the Office of Air and Radiation's Climate Change Division, Climate Economics Branch for 13 years. She conducts economic and policy analysis on a host of issues related to climate change and land use. Specifically, she regularly applies economic and natural science expertise to evaluate how legislative and regulatory policies can potentially affect current and future land use interactions and related GHG emissions fluxes in the forestry,

agriculture and bioenergy sectors, domestically and internationally. Sara and her collaborators use a variety of global, U.S. and regional economic and biophysical models, and historical data such as the U.S. Greenhouse Gas Inventory data and other databases, to produce emissions and sequestration projections for land use systems under different scenarios to assess changes in GHGs, environmental conditions, and welfare effects. She represents EPA on the USG interagency team responsible for generating the land use emissions and sequestration estimates used to inform the US Climate Action and Biennial Reports, as well as the forestry projections used in the 2021 Long Term Strategy and 2016 U.S. Mid-Century Strategy to reduce U.S. emissions by 2050. Sara also contributes to other USG and EPA activities such as serving as the USG expert review co-lead for the Forestry Chapter of the draft IPCC AR6 Working Group III, a government Subject Matter Expert for WGIII Summary for Policymakers' negotiations, and bioenergy elements in the Clean Power Plan and other regulatory contexts. She also led the agency's technical study on assessing net biogenic CO_2 emissions outcomes from stationary sources. Sara brings to EPA prior experience in consulting, economic and market research, and policy analysis, from carbon and water market research with Ecosystem Marketplace at Forest Trends and Yale's Center for Environmental Law and Policy, to five years of working with National Wildlife Federation and then National Audubon Society. At NWF and NAS, she focused on a range of issues including international sustainable development, environmental policy analysis and advocacy/grassroots work. Sara received a Master's in Environmental Management, with an emphasis in Business, Economics and Policy, from the Yale School of Forestry and Environmental Studies and an undergraduate degree in Economics and Environmental Studies from Occidental College in Los Angeles, CA.

Carly Phillips is a Research Scientist with the Science Hub for Climate Litigation at the Union of Concerned Scientists, where she conducts research and provides scientific support for new and on-going litigation. Her research interests broadly include biogeochemistry, ecosystem science, and the intersection of climate science and public policy. Carly's previous research investigated the consequences of warming, vegetation changes, and wildfires on carbon cycling in arctic and boreal systems, and strategies to reduce wildfire emissions and increase forest resilience in British Columbia. She previously worked as a Kendall Science Fellow at UCS and a researcher-in-residence at University of Victoria in British Columbia. Carly is based in western Massachusetts.

Rebecca Scholten is a PhD candidate at Vrije Universiteit Amsterdam in the Netherlands, exploring the dynamic relationship between arctic-boreal fires and climate warming. Her research combines field data and satellite imagery to elucidate shifts in high-latitude fire patterns, placing a special emphasis on extreme fire events. During her PhD she took part in multiple field campaigns gathering unique data on carbon emissions from boreal forest and tundra fires in Siberia, Canada and Alaska. She holds a BSc in Environmental Sciences, a MSc in Environmental Sciences and Remote Sensing, and a MSc in Applied Geoinformatics from Trier University in Germany. Prior to her PhD work, she has conducted research on ecosystem disturbances and environmental challenges in temperate regions at Scion Research Institute in New Zealand and the Joint Research Center in Italy.

Gyami Shrestha spearheaded the U.S. Carbon Cycle Science Program Office at the USGCRP in Washington, D.C. for 11 years, catalyzing interagency and community science products and collaborations. She currently serves as Lynker Corporation Program Director for its emerging carbon, GHG, climate and sustainability portfolio. With multidisciplinary roles in academia, non-profit and private sectors, she has led, advised and/or co-authored over 100 influential publications, presentations, projects, and public engagement opportunities for and with U.S. and international partners. Over a decade ago, she conducted her doctoral research on black carbon or pyrolyzed carbon materials in forest soils of Yosemite National Park, also studying biochar production and policy implications of prescribed fires as a land management practice. Dr. Shrestha began her professional journey in Nepal over 20 years ago, assessing the feasibility and impacts of renewable energy and water technologies, and helping to launch national and regional gender mainstreaming initiatives.

Merritt Turetsky is a Professor, Ecologist, and Carbon Cycle Scientist at the University of Colorado. She has been studying peat consumption and the role of wildfire in northern peatland and permafrost systems for several decades. Her latest work investigates the role of peat versus other fuels in controlling overwintering fires in boreal regions.

Cynthia (Cyndi) Whaley is a research scientist at Environment and Climate Change Canada. She works at the Canadian Centre for Climate Modelling and Analysis, located in Victoria, BC, Canada. Her research interests are on Earth system modelling short-lived climate forcers (SLCFs, such as tropospheric ozone, methane, and particulate matter), and better understanding the interactions between climate and air quality in a changing climate. She worked with the Arctic Monitoring and Assessment Program (AMAP) SLCF expert group on the latest SLCF assessment report, and she is currently on the steering committee of the new International Global Atmospheric Chemistry (IGAC) activity, BBURNED (Biomass Burning Uncertainty: ReactioNs, Emissions, and Dynamics). She is also the coordinating lead on the Hemispheric Transport of Air Pollution (HTAP) white paper for designing a new multi-model, multi-pollutant project focused on fires.

Elizabeth Wiggins is a Research Scientist at NASA Langley Research Center with a PhD in Earth System Science from the University of California Irvine. Her research focuses on understanding wildland fires and their relationships to air quality, weather, and climate.

Key Terminology

Greenhouse Gases (GHGs)

- **Radiative forcing:** Perturbation to the Earth's energy budget due to change in components of the Earth-atmosphere system. Positive forcing suggests warming; negative forcing suggests cooling.

- **Carbon dioxide** (CO_2): long-lived and well-mixed GHG

- **Methane** (CH_4): short-lived GHG with lifetime of ~10 years

- **Other** non-CO_2 gasses

- **Particulates** (PM) or **aerosols,** which are diverse, with generally short-lived (typically days-months) climate impacts

Net Zero: "net zero means cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere" – UN Climate Action

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Wildland Fires

- Fires that originate in the "wildlands," as opposed to structure fires and fires occurring in built environments

- Includes planned and unplanned burns: prescribed fire; cultural burning; management fire; wildfire; rangeland burning (planned and unplanned); as well as escaped agricultural and other planned burns

- Other similar terms: biomass burning; landscape fire; brush fire; bushfire; others

Wildland: Area in which development is essentially non-existent except for roads, railroads, power lines and similar transportation or utility structures – USDA Forest Service

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Land stewardship and "Living with Fire"

- **Land use legacy:** Land condition is a result of past land use and driven by both natural state factors and human land stewardship practices.

- **Fuels management:** Practices and strategies, including land management fires and cultural burning, used as a tool for achieving resilient ecosystems.

- Even in natural systems, humans impact the landscape, and therefore are in a position to practice environmental stewardship.

Environmental Stewardship: The responsible use and protection of the natural environment through conservation and sustainable practices to enhance ecosystem resilience and human well-being.

– Chapin et al., 2010, https://doi.org/10.1016/j.tree.2009.10.008

Charge to Participants

Identify gaps and opportunities in data and models, and changes in land stewardship, that can inform and enhance strategies to limit wildland fire greenhouse gas emissions and associated threats to 'net-zero' emissions targets.

Solution-based Discussions: *(ecosystem and context-dependent)*

- What solutions could contribute to reduced wildfire emissions in the future?

- What solutions can collectively benefit ecological, carbon, and social perspectives? Is there inherently a tradeoff?

- What are the largest data and model gaps and challenges that are necessary to accurately assess solutions?

- At which scale would these solutions have to be implemented to be effective?

- What are the major barriers to implementation?

Breakout Discussion Questions

Day 1

- Which biomes and ecosystems merit the closest attention as climate changes and fire activity increases in some regions of the world? Has the workshop so far overlooked some vulnerable biomes/ecosystems?
- What uncertainties in fire activity or the carbon budget would be good to pin down? What are the major gaps in our knowledge of GHG emissions from fire that have not yet come to light?
- Are there scalable and sustainable methods of land management that have not yet been discussed?
- What synergies and differences are there from biome to biome regarding GHG emissions? What lessons can we transfer from one region to another?

Day 2

- Identify the largest gaps in data, observations, and/or models, which can inform what is needed to reduce uncertainties in carbon emissions to increase the potential for successful mitigation outcomes?
- What are the data gaps and model enhancements that need to be improved to predict the consequences of various proposed mitigation actions on estimates of future fire GHG emissions (e.g., prescribed fire vs wildfire over time)?
- What carbon stocks are most vulnerable to contemporary and future fire? Please consider the mass of potential loss and climate and socio-ecological impacts.

Day 3

- ***Arctic Boreal:***
  - What are climate effective, socially-inclusive, and ecologically-appropriate mitigation efforts to reduce future wildfire emissions?
  - What are the barriers to implementation (trade-offs and co-benefits)?
- ***Temperate:***
  - What are climate effective, socially-inclusive, and ecologically-appropriate mitigation efforts to reduce future wildfire emissions?
  - What are the barriers to implementation (trade-offs and co-benefits)?
- ***Seasonally Arid Tropical Forests & Savannas:***
  - What are climate effective, socially-inclusive, and ecologically-appropriate mitigation efforts to reduce future wildfire emissions?
  - What are the barriers to implementation (trade-offs and co-benefits)?
- ***Tropical Wet Forests & Peatland:***
  - What are climate effective, socially-inclusive, and ecologically-appropriate mitigation efforts to reduce future wildfire emissions?
  - What are the barriers to implementation (trade-offs and co-benefits)?

Padlet Instructions

1.   Navigate to the appropriate Padlet: each breakout discussion will have its own Padlet page. The Padlet is pre-populated with 2 discussion questions and a section for key takeaways.

2.   Use the "+" button beside the question or double-click anywhere in the open space to add your ideas.
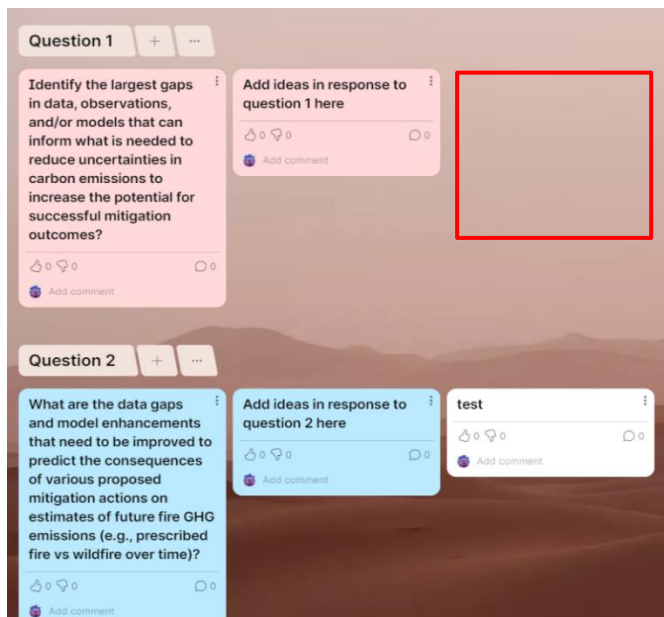
3.   Type your input. Padlet also allows you to add attachments (e.g., links, images, etc.). Click "Publish" to add your post.
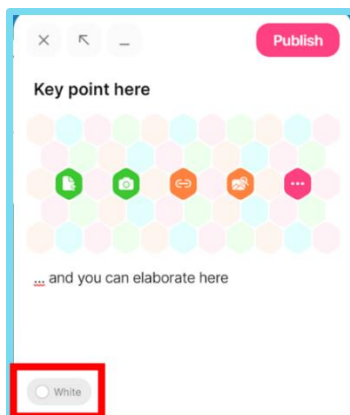
4.   You can "thumbs up" or add comments to posts from others.

Workshop Statement of Task

The National Academies will plan a workshop addressing greenhouse gas emissions (GHG) from wildland fires, with goals of improving measurements and model projections of emissions, informing management practices that could limit emissions, and considering how changes in these emissions could affect the ability to achieve 'net-zero' GHG emissions targets. In particular, the workshop will consider the likelihood of increasing frequency of megafires in remote regions, where management actions are typically limited, and the potential for these regions to be large GHG emissions sources. Workshop discussions will consider the following topics:

- What is current understanding of how changes in wildland fire GHG emissions could affect the ability to achieve 'net-zero' greenhouse gas emissions targets?
- How are GHG emissions from wildland fires measured and estimated? How could these measurements and estimates be improved?
- How are wildland fire GHG emissions projected to change over decade to century timescales? How could these projections be improved?
- How do global climate models incorporate GHG emissions from wildland fires in projections of decadal to centennial climate change?
- What are possible options for wildland fire prevention and forest management practices that could help limit potential GHG emissions? How can indigenous knowledge on forest and emission management be incorporated in current and future action plans? How could these practices be designed to also address impacts of wildland fires on human health, safety, and ecosystems?

Planning Committee Bios

Loretta J. Mickley (*Chair*) is a Senior Research Fellow at Harvard University in the School of Engineering and Applied Sciences. Her research focuses on interactions between climate and atmospheric chemistry. She uses observations and models to investigate the response of air quality to changing climate in the present-day and future. She also examines the two-way interactions between atmospheric composition and climate on a wide range of time scales, including the last glacial period, the preindustrial era, and future. Her recent research has focused on the effects of climate change and human activity on fire and smoke exposure in North and South America, Asia, and Australia. Mickley received an M.S. in chemistry and Ph.D. in geophysical sciences from the University of Chicago. She previously served on the National Academies of Sciences, Engineering, and Medicine's Committee to Review the Climate Science Special Report.

Sally Archibald is a Professor in the School of Animal Plant and Environmental Sciences at the University of the Witwatersrand, South Africa. She works on understanding the dynamics and biogeography of savanna ecosystems and is the co-Principal Investigator of the "Future Ecosystems for Africa" project. Archibald's research on global fire regimes has provided new tools for managing fire in conservation areas to promote biodiversity, and her work on savanna ecosystem functioning is contributing towards better definitions of degradation in tropical ecosystems. Archibald is an associate editor for Ecology Letters and Trends in Ecology and Evolution and serves on the advisory board of the Leverhulme Centre for Wildfires Environment and Society and the Socio-Ecological Observatory for Studying African Woodlands (SEOSAW) steering committee. Archibald received a Ph.D. in ecology from the University of the Witwatersrand.

Chris (Fern) Ferner is a lecturer at Johns Hopkins University and spent the past decade as the wildland fire solutions specialist and disaster response program information manager at Esri. While at Esri, Ferner supported the use of GIS during all aspects of wildland fire including response, recovery, planning, and mitigation. Previously, she served as Esri's wildland fire and public safety technology specialist. Ferner also directly supported agencies and governments around the globe during active incident responses. She has worked professionally in forestry and wildland fire GIS for 20 years. Ferner received a B.S. in biology from St. Andrews Presbyterian College and an M.S. in forestry with an emphasis in GIS and remote sensing from Colorado State University.

Nancy French is a Senior Scientist with the Michigan Tech Research Institute and Adjunct Professor of Forest Resources and Environmental Sciences at Michigan Technological University. She previously worked as a research scientist at the Environmental Research Institute of Michigan. Dr. French has expertise in landscape ecology and in using remote sensing and geospatial approaches for the study of wildland fire and fire effects. In her years of research, she has developed approaches to use satellite data to monitor the spatial and temporal patterns of fire, fuels, and smoke. She has experience in working with satellite images from Landsat, MODIS, and SAR imaging systems. Her work includes integrating remote sensing and geospatial products into decision products, including mapping landscape fuels and quantifying wildland fire emissions of carbon and air pollutants. French received a NASA Earth Science Fellowship and has previously served on the North American Carbon Program Science Steering Group, the Commission for Environmental Cooperation Expert Panel on Black Carbon Emissions Estimation Guidelines, and as a contributing author to the 2nd State of the Carbon Cycle Report. French received a B.S. from Bates College and an M.S. and Ph.D. in natural resources from the University of Michigan, Ann Arbor.

Don Hankins is a Professor of Geography and Planning at California State University, Chico and Field Director for the Big Chico Creek Ecological Reserve. Hankins has been involved in various aspects of land stewardship and conservation for a variety of organizations and agencies including federal and Indigenous entities in North America and Australia. His areas of expertise are pyrogeography, water resources, and conservation. Combining his academic and cultural knowledge as a traditional cultural practitioner, he engages in applied research and projects utilizing Indigenous stewardship practices to aid in conservation and resilience. He is engaged in wildland fire research with an emphasis on landscape scale prescribed and cultural burns; ecocultural restoration; and environmental policy, and has published on these topics. Hankins is an advisor to the Indigenous Peoples Burning Network; founder, co-lead and secretary of the Indigenous Stewardship Network; and an appointed member of the California Wildfire and Forest Resilience Task Force executive committee. Among recent honors, Hankins received recognition with a professional achievement honors as an outstanding teacher-scholar, and as a Grist 50 Fixer. Hankins received a B.S. in wildlife, fish, and conservation biology and a Ph.D. in geography from the University of California, Davis.

He has served on an advisory role in research and policy regarding wildfire emissions and smoke, and has made professional presentations and published articles for public awareness on these topics.

Werner Kurz is a Senior Research Scientist at the Canadian Forest Service of Natural Resources Canada in Victoria, BC. He serves as adjunct professor at the University of British Columbia and at Simon Fraser University. He leads the development of Canada's National Forest Carbon Monitoring, Accounting and Reporting System and the Wildfire and Carbon Project of the Pacific Institute for Climate Solutions. Kurz's research focuses on carbon dynamics in forests and harvested wood products and the opportunities of the forest sector to contribute to climate change mitigation. He has co-authored eight reports of the Intergovernmental Panel on Climate Change. He is an International Fellow of the Royal Swedish Academy of Agriculture and Forestry. Kurz received a B.Sc. in wood science and technology from the University of Hamburg, Germany, a Ph.D. in forest ecology from the University of British Columbia, and an honorary doctorate from the Swedish Land University.

James Randerson (NAS) is the Ralph J. and Carol M. Cicerone Professor of Earth System Science at the University of California, Irvine (UCI). Prior to joining the faculty at UCI, he was an assistant professor at Caltech from 2000-2003. Randerson studies the terrestrial biosphere and the role of fire in the Earth system using high-resolution satellite imagery to identify how fires are changing in response to climate warming and land use intensification. He has conducted field measurements in boreal forests of Siberia and Alaska and temperate forests in California to quantify fire impacts on surface fluxes and atmospheric composition and uses atmospheric models to understand how fires influence atmospheric chemistry, downwind ecosystems, and human health. Randerson received the James B. Macelwane Medal and Global Piers J. Sellers Mid-Career Award from the American Geophysical Union (AGU). He is a Fellow of the AGU and a member of the National Academy of Sciences. Randerson received a B.S. in chemistry and a Ph.D. in biological sciences from Stanford University. Randerson previously served on the National Academies of Sciences, Engineering, and Medicine's Committee on Methods for Estimating Greenhouse Gas Emissions and currently serves on the Committee on the Independent Study on Potential Environmental Effects of Nuclear War.

Randerson leads the science team for the Environmental Defense Fund's FireSat Exploratory Project.

Brendan Rogers is an Associate Scientist at the Woodwell Climate Research Center. He studies the vast expanses of boreal forests and Arctic tundra across Earth's northern high-latitudes, with a particular interest in wildfires and permafrost ecosystems, including feedbacks to the global climate system. He combines field measurements, satellite remote sensing, and modeling to gain insight into rapidly changing carbon and energy cycles, vegetation dynamics, and disturbance regimes. Rogers uses his science to inform natural resource management and policies for improved climate mitigation, adaptation, and ecosystem protection and engages a range of stakeholders and rights-holders, from local community members and fire managers to international policy makers, to explore the societal ramifications of his work. He is deputy lead for Permafrost Pathways, an initiative funded through the Audacious Project that addresses the local to global impacts of permafrost thaw. Rogers received an M.S. in environmental sciences from Oregon State University and a Ph.D. in Earth system science from the University of California, Irvine.

Rogers and Woodwell Climate Research Center have made public statements regarding wildfires, greenhouse gas emissions, and climate change.

Amber Soja is a Physical Scientist in the Chemistry and Dynamics branch at the National Aeronautics and Space Administration (NASA) Langley Research Center, with a focus on Wildland Fire Science Program Management. She is currently serving as a manager for the NASA Applied Sciences Wildland Fire program. Her research uses Earth observations and models as tools to explore the dynamic interactive relationships between fire regimes, fire weather, air quality, the biosphere, atmosphere, and climate systems. Soja developed fire-weather-specific fuels databases and fire emissions that are currently used in field campaigns and models. Her work includes integrating multiple satellite platforms in the Environmental Protection Agency's (EPA) National Fire Emissions Inventory that supports EPA, state, and regional decisions. She has served on the National Science Foundation Wildfire & the Biosphere Innovation Lab panel, the Aerosol-Cloud Convection and Precipitation team for the selection of the Atmospheric Observing System mission, as a Board member the International Association of Wildland Fire, and as a member on the Subcommittee on Disaster Reduction for the National Science and Technology Council development of "Wildland Fire Science and Technology Task Force Final Report." Soja received a B.A. and Ph.D. in environmental sciences from the University of Virginia.

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The National Academies of Sciences, Engineering, and Medicine (NASEM) are committed to the principles of diversity, inclusion, integrity, civility, and respect in all of our activities. We look to you to be a partner in this commitment by helping us to maintain a professional and cordial environment. **All forms of discrimination, harassment, and bullying are prohibited in any NASEM activity.** This policy applies to all participants in all settings and locations in which NASEM work and activities are conducted, including committee meetings, workshops, conferences, and other work and social functions where employees, volunteers, sponsors, vendors, or guests are present.

Discrimination is prejudicial treatment of individuals or groups of people based on their race, ethnicity, color, national origin, sex, sexual orientation, gender identity, age, religion, disability, veteran status, or any other characteristic protected by applicable laws.

Sexual harassment is unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature that creates an intimidating, hostile, or offensive environment.

Other types of harassment include any verbal or physical conduct directed at individuals or groups of people because of their race, ethnicity, color, national origin, sex, sexual orientation, gender identity, age, religion, disability, veteran status, or any other characteristic protected by applicable laws, that creates an intimidating, hostile, or offensive environment.

Bullying is unwelcome, aggressive behavior involving the use of influence, threat, intimidation, or coercion to dominate others in the professional environment.

REPORTING AND RESOLUTION

Any violation of this policy should be reported. If you experience or witness discrimination, harassment, or bullying, you are encouraged to make your unease or disapproval known to the individual at the time the incident occurs, if you are comfortable doing so. You are also urged to report any incident by:

- Filing a complaint with the Office of Human Resources at 202-334-3400 or hrservicecenter@nas.edu, or

- Reporting the incident to an employee involved in the activity in which the member or volunteer is participating, who will then file a complaint with the Office of Human Resources.

Complaints should be filed as soon as possible after an incident. To ensure the prompt and thorough investigation of the complaint, the complainant should provide as much information as is possible, such as names, dates, locations, and steps taken. The Office of Human Resources will investigate the alleged violation in consultation with the Office of the General Counsel.

If an investigation results in a finding that an individual has committed a violation, NASEM will take the actions necessary to protect those involved in its activities from any future discrimination, harassment, or bullying, including in appropriate circumstances **the removal of an individual from current NASEM activities and a ban on participation in future activities**.

CONFIDENTIALITY

Information contained in a complaint is kept confidential, and information is revealed only on a need-to-know basis. NASEM will not retaliate or tolerate retaliation against anyone who makes a good faith report of discrimination, harassment, or bullying.

Updated December 2, 2021

Complaints regarding violations of the National Academies anti-harassment policies should be reported by:
- Filing a complaint with the Office of Human Resources at 202-334-3400 or hrservicecenter@nas.edu or
- Reporting the incident to an employee involved in the activity in which you are participating.

Complaints of harassment, discrimination, or bullying should be filed as soon as possible after an incident. The Office of Human Resources will investigate the alleged violation in consultation with the Office of the General Counsel.

A GUIDE TO THE
Harassment Complaint Process for Participants
AT THE NATIONAL ACADEMIES

Review the Policy [here](#).

When reporting an incident, please provide as much of the following information as is possible and applicable:
- Name and role of the person or persons allegedly causing the harassment;
- Description of the incident(s), including the dates, locations and the presence of any witnesses;
- Steps taken to try to stop the harassment; and
- Any other information that may be relevant.

If the National Academies determines that a participant in a National Academies activity has violated this policy, the National Academies will take action as it deems appropriate to address the situation and to prevent the participant from engaging in future discrimination, harassment, or bullying in National Academies activities, up to and including banning that individual from current or future participation in National Academies activities.

All inquiries, complaints, and investigations are confidential, and information is revealed only on a need-to-know basis. Information contained in a complaint is kept confidential. The National Academies will not retaliate or tolerate retaliation against anyone who makes a good faith report of discrimination, harassment, or bullying. or participates in a complaint investigation.

For more information, please watch the following videos from our Expert Volunteer Orientation:
- Making a Commitment to Diversity, Equity, and Inclusion
- Preventing Discrimination, Harassment, and Bullying