INITIATIVE ON
Extreme Weather and Climate
COLUMBIA UNIVERSITY

Advances in global fire prediction on daily to decadal timescales

James Randerson, Department of Earth System Science, UC Irvine
Yang Chen, Department of Earth System Science, UC Irvine
Padhraic Smyth, Department of Computer Science, UC Irvine
Zachary Butler, Department of Computer Science, UC Irvine
Niels Andela, Biospheric Sciences Branch, NASA Goddard Space Flight Center
Douglas Morton, Biospheric Sciences Branch, NASA Goddard Space Flight Center
Sander Veraverbeke, Vrije Universiteit Amsterdam

Over the past two decades, high quality satellite measurements of burned area and fire thermal anomalies have enabled breakthroughs in our understanding of climate, ecosystem, and human controls on fire dynamics. Here we highlight three challenges for fire prediction that span time scales ranging from the duration of a numerical weather forecast to the long-term influence of 21st century climate change. On daily time scales, an important prediction challenge is to forecast fire emissions from multiple, simultaneously burning fires to improve smoke forecasts. To address this challenge, we discuss a new algorithm developed at UCI that predicts emissions for multiple fire clusters using the past history of active fires and climate variables from a weather forecast. Considering seasonal to interannual timescales, we will describe recent work highlighting the importance of El Niño-Southern Oscillation as a global driver of fire predictability. A key finding is that ENSO triggers a cascade of fire activity across different tropical continents, enabling lead times for prediction that may exceed a year in some regions. While considerable progress has been made in understanding how fire weather indices may change in response to 21st century climate warming, the atmospheric processes regulating lightning remain poorly understood. Here I will describe how lighting was a major driver of recent fire extremes in boreal forests of North America. Changes in air temperature and convective precipitation in the Arctic suggest this biome may become lightning-rich in the future, increasing risk to permafrost carbon and accelerating the northward migration of boreal forests