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A Global Fire Atlas of size, duration, and spread from satellite burned area data

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Fire regimes are changing rapidly around the world, but the exact mechanisms through which humans and climate affect global fire regimes remain poorly understood. Global burned area data from NASA's MODIS sensors capture nearly two decades of global fire activity, required for time series analysis. These data provide daily estimates of fire affected area, that can be used to understand the dynamics of individual large fires ($\geq$25 ha). Here, we present a new global dataset, the Global Fire Atlas, including six data layers that characterize global fire regimes: ignitions, fire size, duration, speed, fire line extent, and direction of fire spread. The Global Fire Atlas is based on Collection 6 MODIS 500-m daily burned area data (MCD64A1). By separating individual large fires, we first divide burned area (BA) into the number of fire ignitions (I) and their corresponding fire sizes (S) (BA = I x S). Fire size can be further described as a function of duration (D), fire line (FL) and velocity (V) (such that S = D x FL x V). Subdividing burned area into these different components is a critical first step in understanding human and climatic controls on fire, as each component may respond differently to changing human land management or climate variability.

Global contributions of ignitions and fire size to burned area were dictated by ecosystem gradients and land management. Ignitions were an important driver of total burned area in agricultural landscapes and the humid tropics, while fire size was the dominant driver in natural landscapes and arid regions. Multi-day fires were the norm across all major biomes, and fire duration was a strong control on fire size in the humid tropics and boreal regions. In arid regions, higher fire velocities allowed fires to grow rapidly, resulting in shorter duration fires based on fuel limitations. Strikingly, the inter-annual variability and trends in burned area were strongly influenced by large fires, with a more stable contribution from small fires in all years (2003-2016). Fragmented landscapes reduced fire size, frequency, and variability, with both lower burned area and less variable fire regimes in human-dominated landscapes. Variability or change in climate may therefore particularly impact protected areas and natural ecosystems.