The extreme fall 2016 wildfire season of the Southern Appalachians

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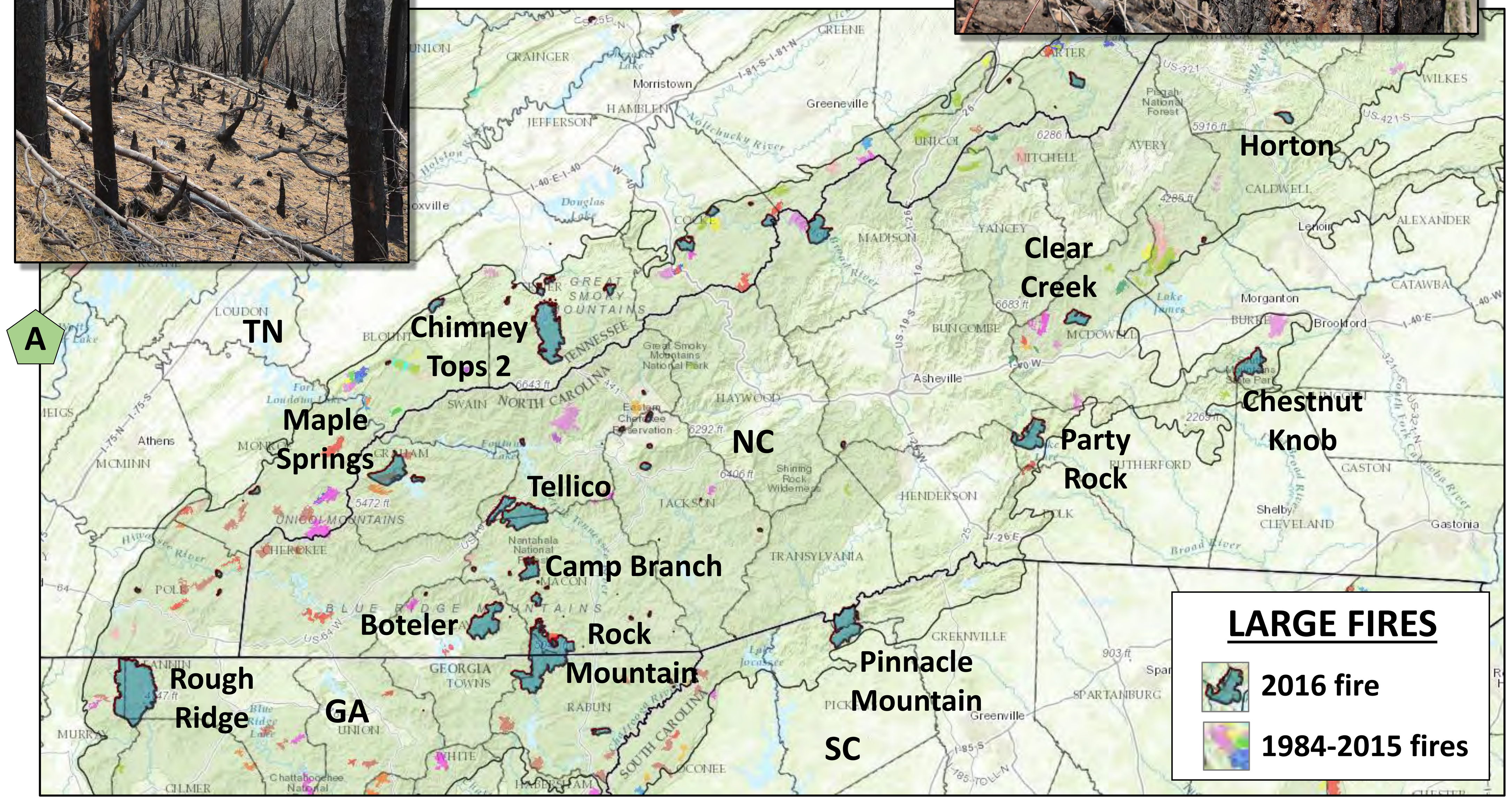
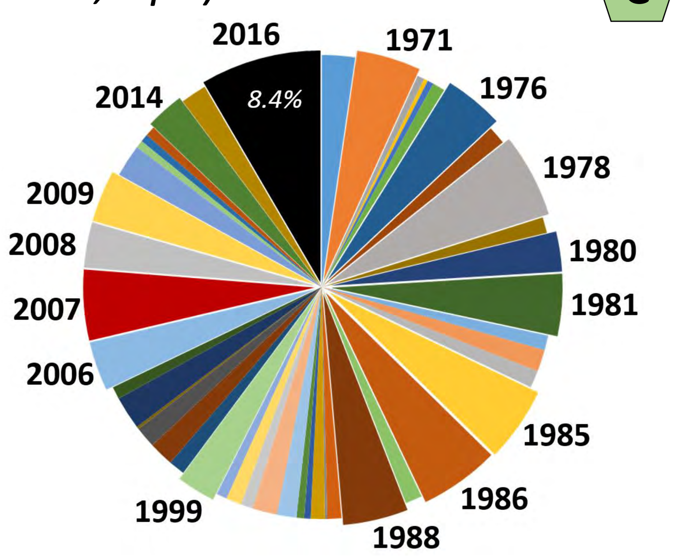
The seasonality of Appalachian wildfire

There is abundant historical and paleo evidence of fire in the Southern Appalachians, but until the fall of 2016, widespread large, long-duration fires were thought to be unlikely. From mid-October through November of 2016, a rash of human-ignited fires (and at least two large lightning fires) burned over 140,000 acres **[A]**. These fires were not just remarkable for the land area burned, but for their smoke and duration, the more mesic and rocky sites that burned, and the extreme fire behavior that was sometimes observed. The fire season came to a climatic close when hurricane force winds forced the Chimney Tops 2 Fire from Great Smoky Mountain National Park into nearby communities where it damaged or destroyed over 2000 homes, injured hundreds and caused death to 14.

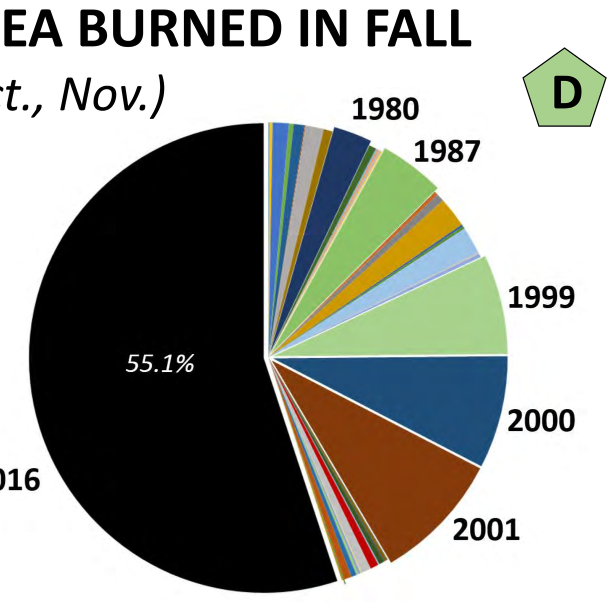
Most wildfires and prescribed fires occur in the late winter to early spring, prior to the growing season. Until 2016, the majority of the area burned on public lands since 1970 was also early in the year. Increased moisture during the growing season keeps fires small, despite the warmer temperatures of summer. Summer humidity contributes to a largely bimodal fire seasonality with peaks in spring and fall with fires that are predominantly of human origin **[B]**. Even prior to 2016, the annual predictability of area burned was much greater in spring **[C]** than fall **[D]**. Remarkably, as much area burned in October and November of 2016 as had during all 46 prior fall seasons combined **[D]**.



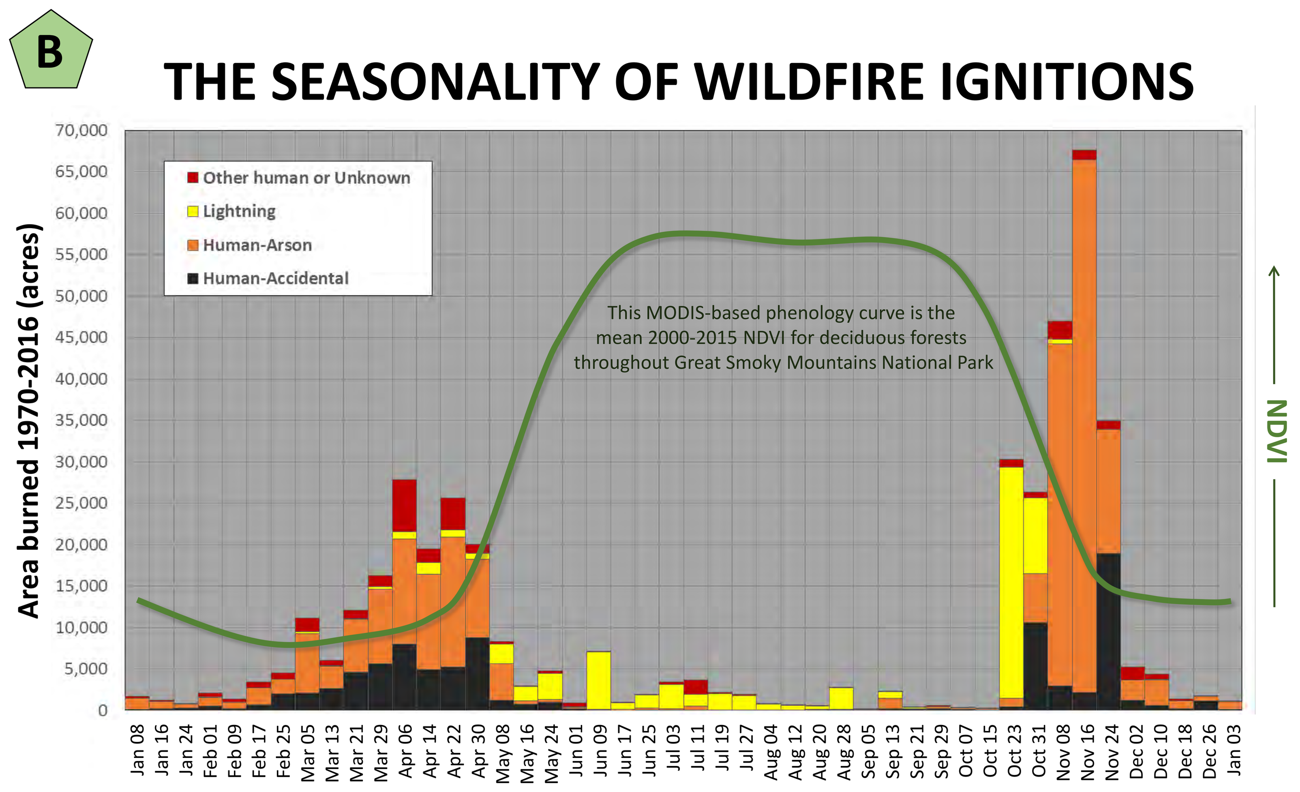
AREA BURNED IN SPRING
(Mar., Apr.)



AREA BURNED IN FALL
(Oct., Nov.)



THE SEASONALITY OF WILDFIRE IGNITIONS

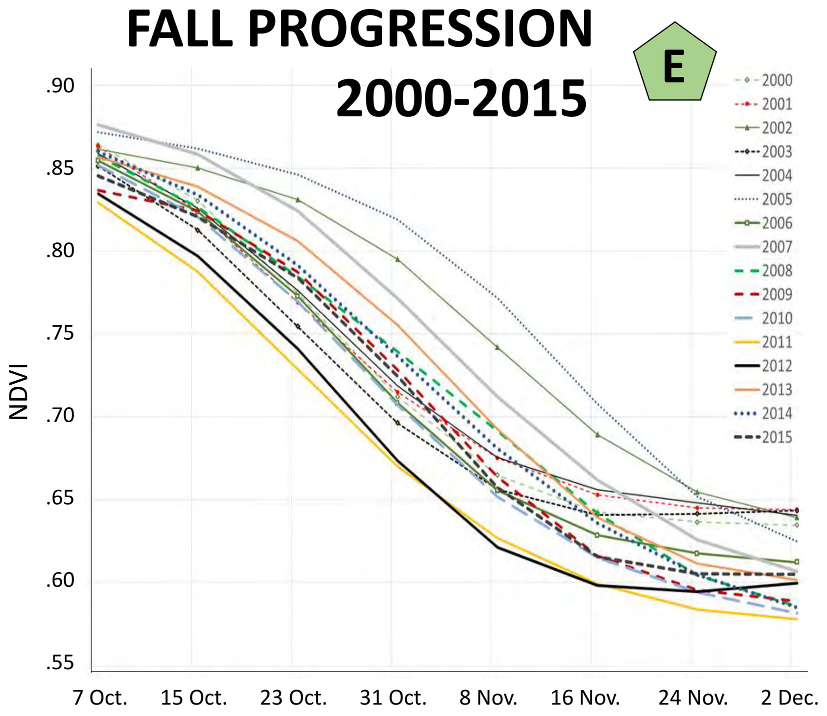


Fall fuel phenology

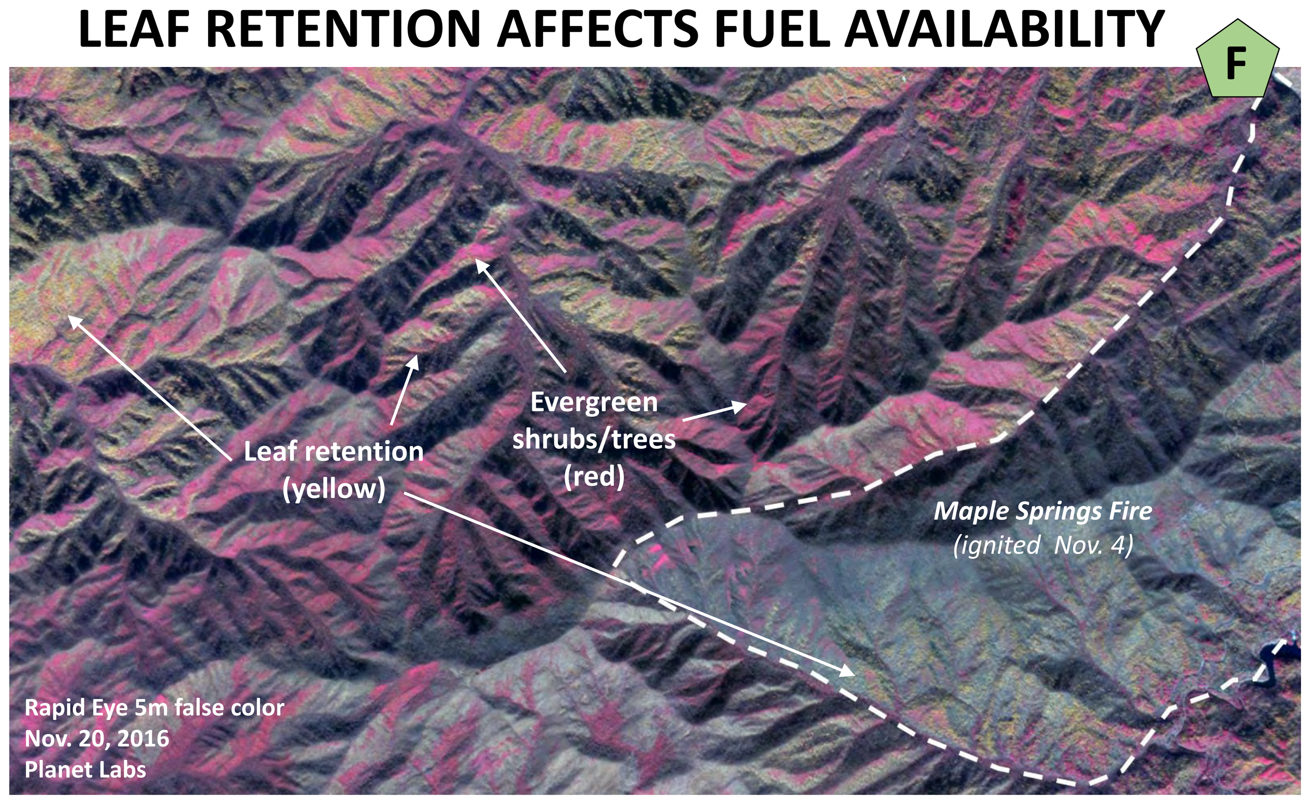
Vegetation phenology broadly controls the cessation of the spring and the onset of the fall fire seasons **[B]**, so it seems possible that variation in the timing of these seasonal transitions could temper the timing and duration of these two fire seasons. From high-frequency MODIS satellite data since 2000, fall declines in the Normalized Difference Vegetation Index (NDVI) vary by over 2.5 weeks **[E]**. Research from Great Smoky Mountains National Park indicates that leaf senescence, which is captured by NDVI, is accelerated by summer drought and delayed by fall warmth. These conditions could affect the onset and duration of the fall fire season by affecting both fuels and fire behavior.

Leaves of xeric species like oaks typically linger long after senescence. In 2016, abscission may have been further delayed from the lack of storms. By late November, leaf retention persisted on dry, protected, oak-dominated slopes according to high resolution imagery **[F]**. According to fire responders, continuously falling leaves made it more challenging to retain the integrity of control lines, and then, when winds picked up late in the season, mobilized leaves contributed to fire spread. This dynamic may have helped move fire into portions of the landscape that are generally more difficult to burn, such as mesic or boulder-dominated sites.

FALL PROGRESSION 2000-2015



LEAF RETENTION AFFECTS FUEL AVAILABILITY



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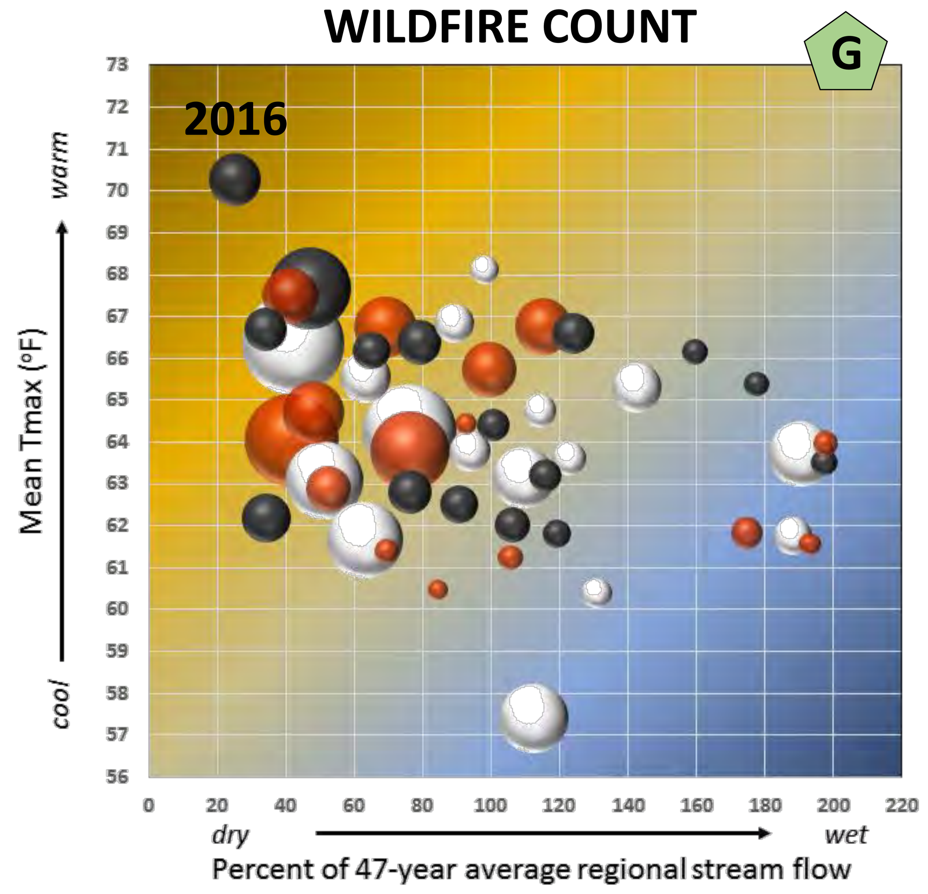
The role of drought, heat and ignitions

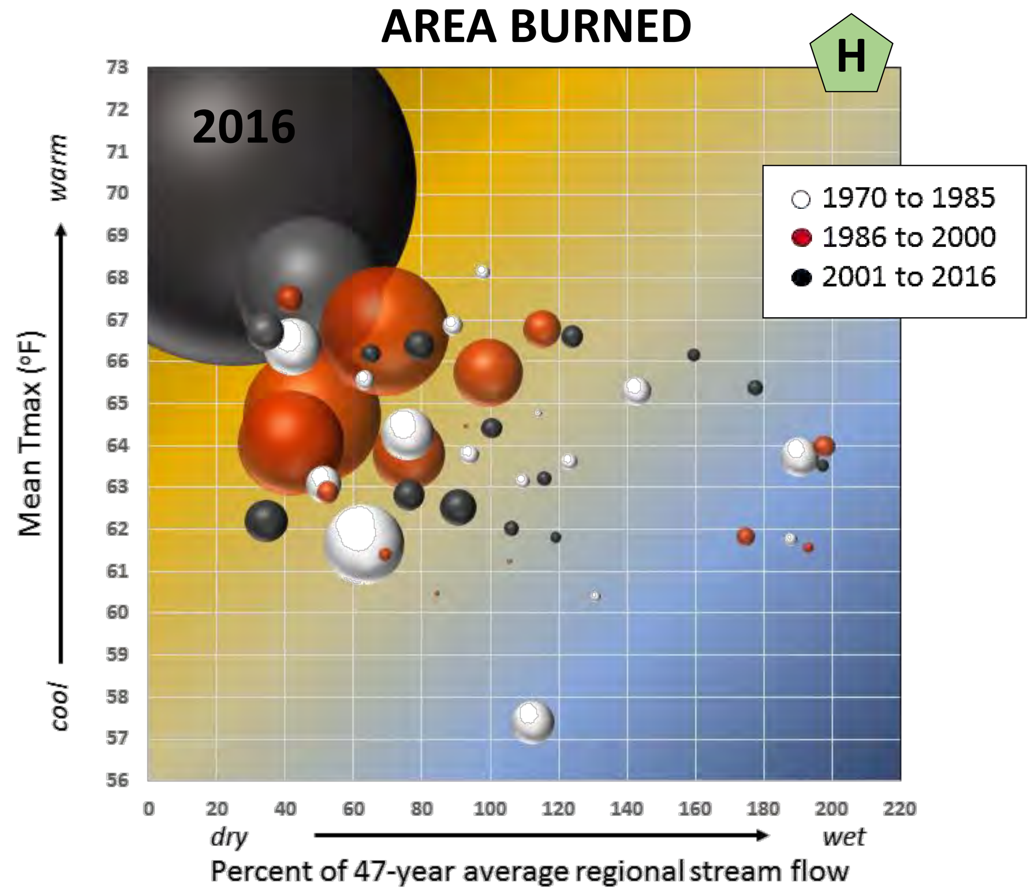
The fall of 2016 experienced a warm drought that was particularly severe in the southwestern half of the Southern Appalachian region. While drought is known to increase fire activity across many natural systems, this fire regime is driven by human ignitions such that the role of climate is less clear. In the graphs below, the x-axes reflect the average October-November flow for 10 unimpounded watersheds across the region. The y-axes show the mean maximum October-November temperature for three NOAA Climate Divisions (NC1, TN1, and GA2; *ftp.ncdc.noaa.gov*). Sphere diameter shows the relative count **[G]** or area burned **[H]** during a given year's fall fire season. Fire data is for the region's five National Forests and Great Smoky Mountains National Park, where wildfire records are generally reliable back to 1970.

The count of fall fires **[G]** increases when the season is warm and dry, particularly when fires during the early 1970s are ignored because arson ignitions were more common then. Area burned **[H]** shows a much greater dependence on drought-temperature conditions, but *extreme seasonal fire weather is no guarantee of a large area burned*. This unexpected result may reflect differences in where human ignitions occur with respect to large landscape fuels patches. Moreover, this nuanced relationship between drought, heat and ignitions suggests opportunities for targeted wildfire prevention.

WILDFIRE COUNT



AREA BURNED



Since 1970, ignitions were common in spring and fall when the Palmer Drought Severity Index (PDSI) was wet (0 to 2.5), dry (-2.5 to 0) or extremely dry (<-2.5) **[I]**. In contrast, less area was burned in spring when it was wet, while extreme drought is the typical condition when fall wildfires ignite **[J]**.

The sensitivity of the Southern Appalachian fall fire season to drought and temperature is of particular concern, given seasonally-high human caused ignitions, predictions of a warmer future climate, the potential for long-duration smoke and its health effects, and an expanding wildland-urban intermix.