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Short Contribution

Fire for the Ages: Proxy Reanalysis and Modern Relevance of the March 1906 Southern Great Plains Megafires

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ABSTRACT

The National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) 20th Century Reanalysis (20CR) is used to estimate synoptic-scale atmospheric conditions associated with historic accounts of two very large wildfires, one of which reportedly burned >24 281 km^2 (>6 million acres) on the southern Great Plains of New Mexico and Texas in March 1906. The reanalysis reveals atmospheric features consistent with recent wildfire outbreaks and megafires in the region. Fire perimeter mapping of modern megafires that occurred under similar meteorological conditions in the same geographical region were modified to approximate the reported dimensions of the March 1906 fires. Connecting the past to the present provides historical precedence and context for the escalation of southern Great Plains wildfire outbreaks and megafires observed in the region during recent decades. Fire, land, and emergency management officials, as well as fire forecasters, can use this proxy reanalysis as a reference point for planning. It illustrates a potential worst-case scenario for the plains fire regime without modern land use practices and fire suppression.

1. Introduction

The history of the southern Great Plains is littered with accounts of immense wildfires on the untamed prairie. In fact, "prairie fire occurred with astonishing frequency and caused much destruction and loss", and was considered to be one of the most dreaded of all hazards facing early settlers on the frontier during the late 19th and early 20th Centuries (Rickard 1934).

The 26–27 February 2024 Smokehouse Creek Fire that burned 4283 km^2 (1 058 352 acres) in the Texas Panhandle and western Oklahoma was one of the largest single contiguous wildfires to impact the United States (U.S.) in modern times (Pulver 2024). The occurrence of such a large and destructive fire has heightened awareness of the devastating potential posed by wildfire on the southern Great Plains. While

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the first two decades of the 21st Century saw a dramatic increase in southern Great Plains megafires (defined as wildfires ≥404 km^2 or ≥100 000 acres, Lindley et al. 2019), until recently, fires ≥4047 km^2, or ≥1 million acres (sometimes called “gigafires”) were a hallmark of a bygone era. Historians point to conflagrations that approached or exceeded a million acres and ravaged the prairies more than a century ago, but fires of such scale were a phenomenon removed from the collective Great Plains’ memory and ecology. From historic accounts, reports of one particular fire stand out for its enormity. In March 1906, a wildfire reportedly burned >24 281 km^2 (>6 million acres) of eastern New Mexico and western Texas, with a second nearby megafire that concurrently burned ~1554 km^2 (384 000 acres) during the same fire weather episode. Although these incidents pre-date modern fire reporting and do not appear in official governmental records (to our knowledge), if confirmed the former would rival the largest fires ever documented on the North American continent (Pyne 2012).

Although wildfires of such scale were absent from the region’s fire regime for the remainder of the 20th Century, they are now returning with devastating consequences. Beginning with the 1988 Big Country Fire in Texas, and then accelerating after the 2006 East Amarillo Complex to include an epidemic of eight Texas megafires in 2011, the 2016 Anderson Creek Fire (Oklahoma/Kansas), the 2017 Perryton (Texas) and Starbuck Fires (Oklahoma/Kansas), and now Smokehouse Creek (Texas/Oklahoma); all of these incidents successively established modern-day records for size in their respective states. Additional megafires also occurred on the plains in 2008, 2018, and 2021. Here, we show that this recent escalatory emergence of modern megafires on the southern Great Plains is not novel to the past two decades. Instead, it is a reemerging relic from the prairies’ past.

This paper uses available historical texts documenting the March 1906 prairie fires, in conjunction with the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) 20th Century Reanalysis (20CR, Slivinski et al. 2021) daily composites of estimated synoptic-scale atmospheric conditions, and mapping of modern plains megafires under similar meteorological conditions, to produce a to-scale, map-based proxy of the March 1906 megafires on the southern Great Plains. This proxy provides modern fire forecasters, fire analysts, and emergency management officials a visual reference for what is suspected to be one of the largest wildfires ever encountered on the southern Great Plains. In addition, the 20CR composites presented here establish historical precedence for the occurrence of wildfire outbreaks and megafires under similar weather patterns to those that promote high-impact wildfire episodes in the region today.

2. Modern relevance: back to the future of plains fire

Toward the end of the 20th Century, the character of fire on the southern Great Plains seemed to change. In 1988, two March fires in Callahan County, Texas, swept over 1360 km^2 (336 000 acres), and in late February 1996, an 81 km^2 (20 015 acres) fire northwest of Fort Worth, Texas, consumed 65 houses and 90 outbuildings and injured 52 firefighters and civilians. Between them — a massive fire in the countryside, a damaging fire in the exurbs — the two seasons of 1988 and 1996 inaugurated what appeared to many observers as a phase change in the traditional dynamics of Southern Great Plains fires. A cavalcade of conflagrations followed, year after year, each breaking former records. Yet these fires were not unprecedented.

Long ago, vegetation, weather, sparks, and a climatic cadence of wetting and drying congealed into a matrix that ensured the southern Great Plains would burn. The first European report of landscape fire in North America came from Texas in 1529. The earliest travelers to the region expected to witness fire as much as they did bison. Rare were settler accounts that did not feature horizon-sweeping prairie fires (Courtwright 2011). Settlement disrupted the old regime. Initially, it expanded vegetation in ways that fueled large fires (primarily through removal of bison herds which led to abundant ungrazed grassy vegetation), then eventually agriculture removed, replaced, or partitioned that growth in ways that shrank big burns. Traditional sources of ignition receded, and monster burns disappeared into historic memory.

Still, the fundamental matrix endured. A changing climate and evolving fuelscape added energy to the system. The prime season for burning has lengthened, and people have added and rearranged combustibles and placed communities in riskier settings (Balch et al. 2024, Murdoch et al. 2025). The old conditions that favored large fires have updated and strengthened. Today’s fires bear a close resemblance to the great fires of yesteryear. The megafires of 1988, 2006, 2008, 2011, 2016, 2017, 2018, 2021, and 2024 have precedents in the gigafires of 1879, 1894, 1895, 1896, 1902, 1903, 1904, and 1906 (Haley 1929, Rickard 1927, 1934, 1945, Box 1967, and Pyne 1982, 2012, 2017). By way of illustration here, we compare the 2006 East Amarillo Complex and 2024 Smokehouse Creek Fire to the fires of 1906; incidents that burned more than one million acres of prairie, but were separated by more than one hundred years.

3. Data and methods

Table 1 summarizes utilized data sources, defines whether they are based on original reporting versus derived post-event, and classifies their procurement as literature review, observed, or analyzed. The list below itemizes three of the most useful historical accounts obtained from literature review with the most pertinent details used to shape our analysis underlined:

- "In March of the same year [1906] another fire originated in the heart of New Mexico and, fanned by a high west wind, soon spread to Texas. It destroyed all the grass…in about ten Texas counties, and burned an area about 150 miles long and from ten to sixty miles wide. Frequent changes of wind made fire-fighting difficult, and played an important part in another fire that burned about six hundred sections of land in Lynn, Garza and Lubbock counties." (Rickard 1934).
- "[In the Texas Panhandle]…in 1906 over 6 million acres burned in a single fire" (Pyne 1982).
- "Roswell, N.M., March 3 Over 1,000,000 acres of fine pasture land in the eastern (clearly an error based on reference to Portales, New Mexico, should be "western") part of the Panhandle and just east of Portales, N. M., have been burned in a prairie fire that has been sweeping east and south for two days and is still beyond control with its head fifteen miles wide and under a stiff wind." (Dallas Morning News, 4 March 1906).

The Dallas Morning News report on 3 March 1906 provides the most definitive dating available for the conflagration of interest and is the basis for the 20CR Daily Composites for 1–3 March 1906. Corresponding U.S. Daily Weather Maps (NOAA, cited 2024) illustrate the potential limitations of the reanalysis due to the sparse observational networks that existed at that time, but general agreement between the datasets also corroborates weather systems depicted by the 20CR composites and supports their utility to infer synoptic-scale weather conditions that contributed to the March 1906 mega-prairie fires.

In order to ensure relevance to recently observed fires that have occurred in the region, modern perimeter mapping of reference fires that occurred under similar circumstances were manipulated using Geographic Information System (GIS) techniques to develop proxy fire maps of the 1906 megafires. The Smokehouse Creek Fire perimeter (NIFC 2025a, shapefile link) was modified via smoothing, clipping, and stretching techniques in ArcGIS to approximate the reported dimensions of the '>6 million acre' burn area. The 12 March 2006 Highway 152 Fire [one of two megafires within the East Amarillo Complex, (NIFC, 2025b shapefile link)] was similarly used as a starting reference for the secondary nearby fire. We do not aim to accurately map the fires' true perimeters or geographies that cannot be precisely known based on the limited knowledge derived via literature review and historical evidence.

Further, the authors note many historical sources also reference another conflagration of "over a million acres" (≥4047 km^2) that burned portions of eastern New Mexico and the western Texas Panhandle in November 1906. This later fire is described as originating near Fort Sumner, New Mexico, and is prominent in historical accounts from the XIT Ranch in Oldham and Deaf Smith Counties, Texas, where the fire is said to have stopped near Hereford (Patterson 1964) as snow fell over the region [the 24 November 1906 editions of the El Paso Times (1906); The Houston Post (1906); and The Fort Worth Record and Register (1906); and the 25 November 1906 edition of The Borden Citizen (1906)]. The authors believe that the Fort Sumner-to-Hereford

Table 1. Data sources defined as either based on original reporting or derived post-event and procurement method.

Data Source Material, Original versus Derived, and Procurement		
Newspapers	Original	Literature Review
Academic/Nonfiction Publications	Derived	Literature Review
U.S. Daily Weather Maps	Original	Observed
20CR	Derived	Analyzed
Reference Fire Perimeters	Original	Observed

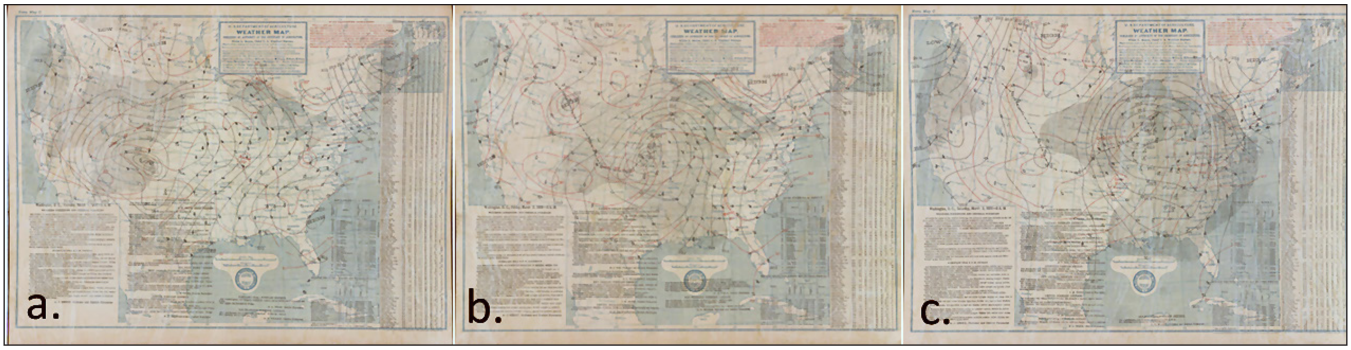

Figure 1. U.S. Daily Weather Maps for 1–3 March 1906, (a–c respectively). *Click image for an external version; this applies to all figures and hereafter.*

line demarks an effective northern limit to any possible representation of the March 1906 burn area, because ambient fuels would have been reduced by the March fire and unavailable to support subsequent large scale fire occurrence in November.

4. Meteorological reanalysis

The Daily Weather Maps (Fig. 1a–c) show a well-developed surface low and associated frontal features initialized at 29.00 inHg (982 hPa) over central Colorado at 0800 (EST) 1 March 1906. By 0800 2 March, the low was centered over northeastern Kansas at 989 hPa (29.20 inHg) with an appendant cold front analyzed over southwestern Kansas and southeastern Colorado. The storm system was noted over southern Wisconsin by the morning of 3 March, with the associated cold front well south of Texas.

20CR Daily Composites produced for 1–3 March are consistent with the Daily Weather Maps. At 500 hPa, the reanalysis shows daily mean geopotential heights indicative of a midlatitude cyclone translating over the central U.S., initially as a trough over the Intermountain West on 1 March, then deepening to a 540 dam closed low over Kansas on 2 March, and eventually a deep and negatively tilted cyclone with a 535 dam low over Iowa on 3 March (Fig. 2a–c).

Daily mean sea level pressure (SLP) reanalysis (Fig. 2d–f) shows a surface reflection of this storm system similar to those observed in the Daily Weather Maps. A 990 hPa surface low is initialized on 1 March over southeastern Colorado. Then, the low is shown as 997.5 hPa over northeastern Kansas and far southeastern Nebraska on 2 March, and finally a 1000 to 1002.5 hPa low near Chicago on 3 March. Intense surface pressure gradient-induced south, southwest, and westerly winds are shown over the southern Great Plains on 1 March (Fig. 3a). Of particular note are analyzed 10–11 m s^{-1} (~20 kt) 950 hPa (proxy for the surface due to 20CR limitations) southwesterly winds over the plains of eastern New Mexico, where daily average relative humidities (RH) of 30 to 40% are analyzed within a notable downslope flow regime (Fig. 3d). Dry air advanced eastward onto the plains of west Texas on 2 March with widespread average daily RH <20% as winds veered to the west and eventually the northwest at daily average speeds as high as 10 to 13 m s^{-1} (20 to 25 kt) as a cold front aggressively pushed south across the region (Fig. 3b and e). With analyzed average daily RH <40% over eastern New Mexico and west Texas during the period, the reanalysis suggests an environment supportive of a continuous diurnal burn period throughout 1–3 March. The analysis also shows a very dry post-frontal air mass over the region on 3 March with widespread RHs <30–40% (Fig. 3c and f).

On the southern Great Plains, the presence of a fire-effective low-level thermal ridge (LLTR) is commonly tied to the occurrence of significant wildfire activity. Fire-effective LLTRs are defined as narrow poleward-oriented zones of anomalously warm near-surface air that are overspread by approaching mid-tropospheric wind maxima (Lindley et al. 2017). The juxtaposition of these atmospheric features promotes downward momentum transfer of strong winds aloft into a hot and dry boundary layer that exacerbates wildfire ignition, spread, and behavior. While the evolution, location, and ultimate fire-effectiveness of LLTRs within parent large-scale weather systems are governed by mesoscale process, synoptic-scale signals of a fire-effective LLTR are evident in the reanalysis on 1 March (Fig. 4a and d). A broad and well-developed ≥285 K (≥12°C) LLTR is depicted in the daily mean 2-m temperature field extending north-to-south from southwestern Kansas into west Texas. While these temperatures are cooler

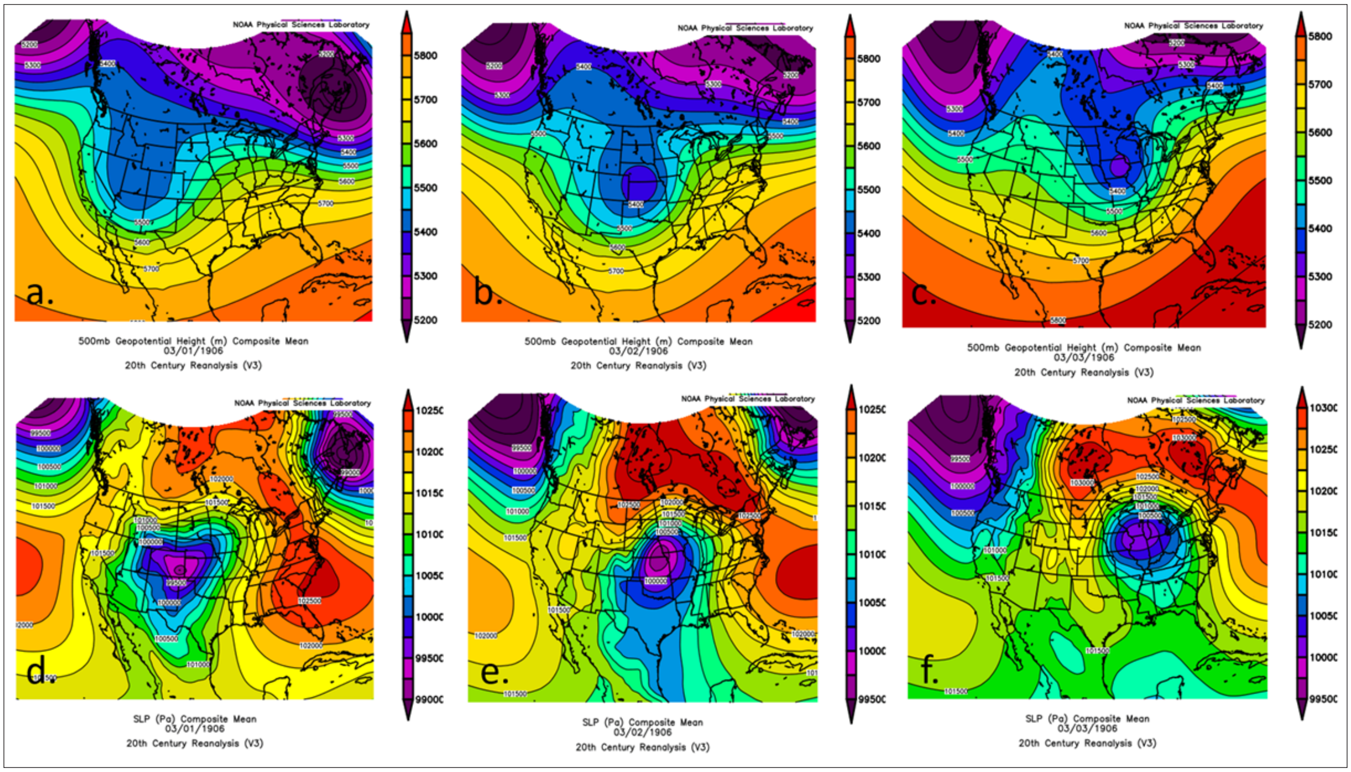

Figure 2a-f. NCEP/NCAR 20CR Daily Composites valid 1–3 March for a–c) 500 hPa geopotential heights and d–f) SLP.

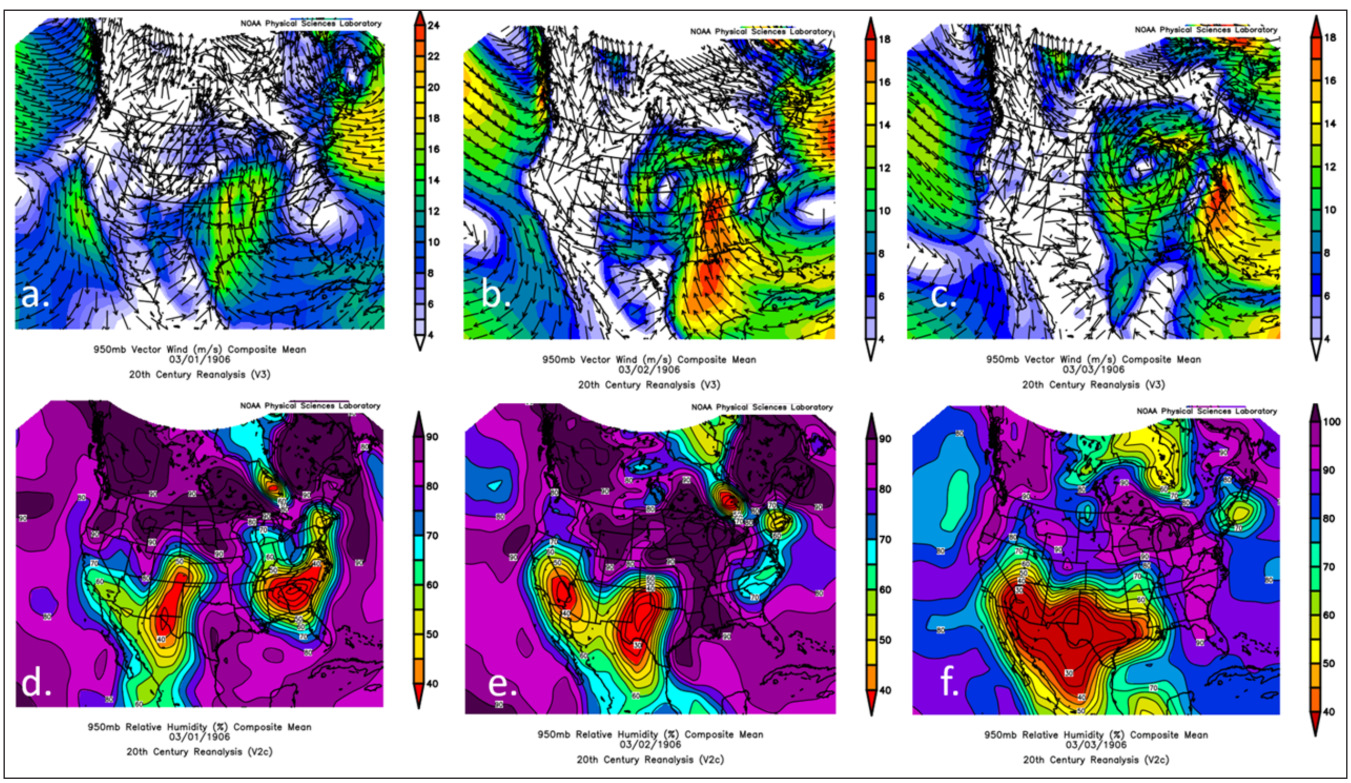

Figure 3a-f. NCEP/NCAR 20th Century Reanalysis Daily Composites valid 1–3 March for a–c) 950 hPa vector wind and d–f) 950 hPa RH (proxy for 2-m RH and only available in V2c).

than those typically seen in fire-effective LLTRs, we emphasize that the reanalysis depicts daily means, so the fact that a LLTR signal is evident suggests that near-surface temperatures during the peak diurnal burning period were likely much warmer. Meanwhile, a ≥30 m s^{-1} (≥58 kt) 500 hPa wind maximum is analyzed within cyclonically curved flow rounding the base of the approaching upper air trough. The jet's front exit region is shown infringing eastward over the windward side of the LLTR. This is a known extremely critical fire weather scenario in the region that has been a commonality to many of the dangerous wildfires on the southern Great Plains in modern times, including the Smokehouse Creek Fire. The midlevel jet is shown by the reanalysis to intensify as the parent upper air low propagated east on 2–3 March (Fig. 4b–c), and the LLTR was suppressed and pushed well eastward with time as the aforementioned cold front pushed southward across the Southern Great Plains (Fig 4e–f).

5. Discussion and operational utility

While the sub-synoptic scale details and diurnal peak magnitude of features associated with the weather system of 1–3 March 1906 are unquestionably not resolved by the reanalysis, evolution of the synoptic pattern shown by the 20CR composites is consistent with modern-day Southern Great Plains Wildfire Outbreaks (SGPWOs) and Great Plains megafires (Fig. 5a–c). Twenty-first Century observations of SGPWO-bearing midlatitude cyclones and conceptual models useful in their prediction feature the daytime passage of a progressive low-pressure system over Kansas (Lindley et al. 2014). The timing and configuration of these cyclones promote the previously described alignment of intense wind fields aloft with a LLTR. Consistent with the timeline reported in the Dallas Morning News, corroborated by similar reporting in the Fort Worth Star-Telegram (1906), it is inferred that the largest fire originated (either as a new ignition or run of a pre-existing burn) on the plains of eastern New Mexico within the analyzed downslope regime on 1 March. This is substantiated by the 20CR-depicted interaction of the LLTR and overspreading midlevel jet (Fig. 6a–b), and is an atmospheric process commonly associated with the emergence of intense wildfire episodes in the region today (Lindley et al. 2017). The reanalysis depiction of these features lends some degree of confidence in approximating the latitude of the fire's point of origin and initial rapid spread in eastern New Mexico, likely

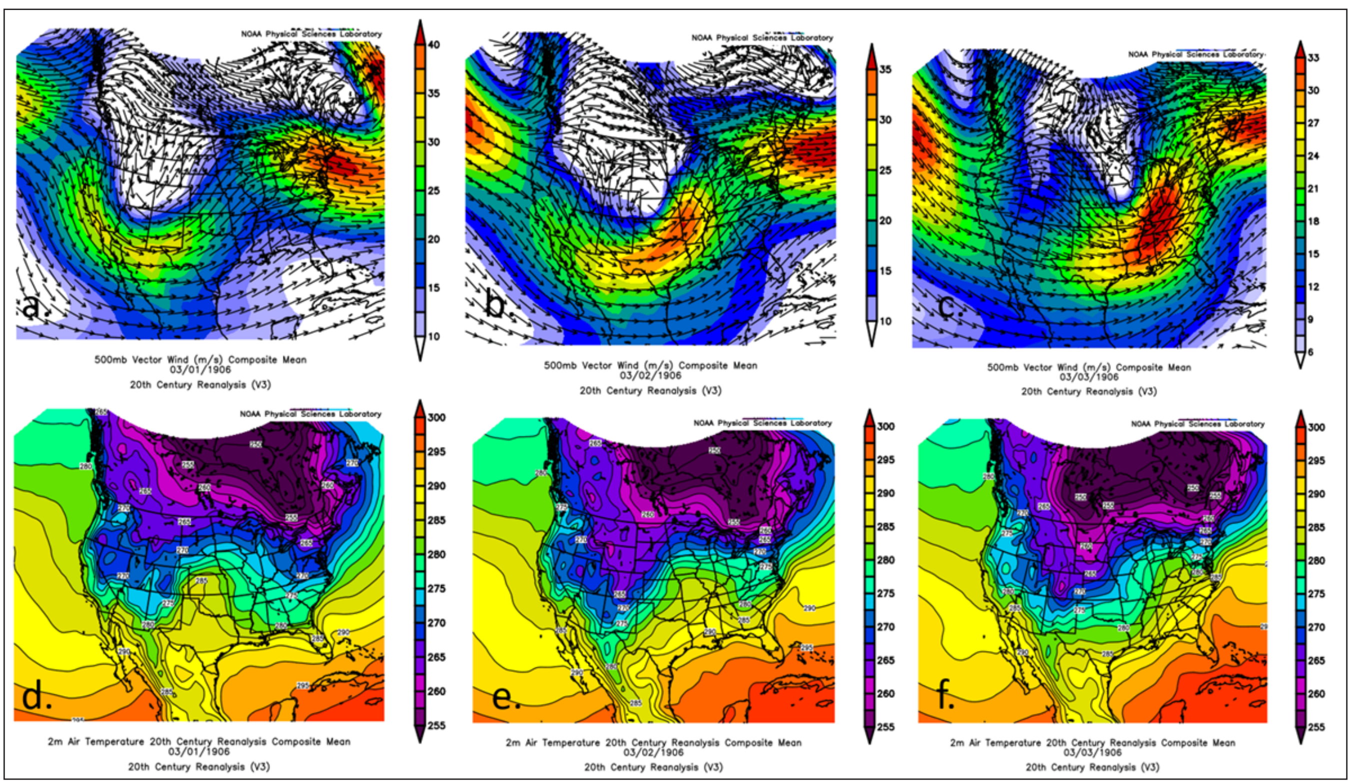

Figure 4a-f. NCEP/NCAR 20CR Daily Composites valid 1–3 March for a–c) 500 hPa vector wind and d–f) 2-m temperature.

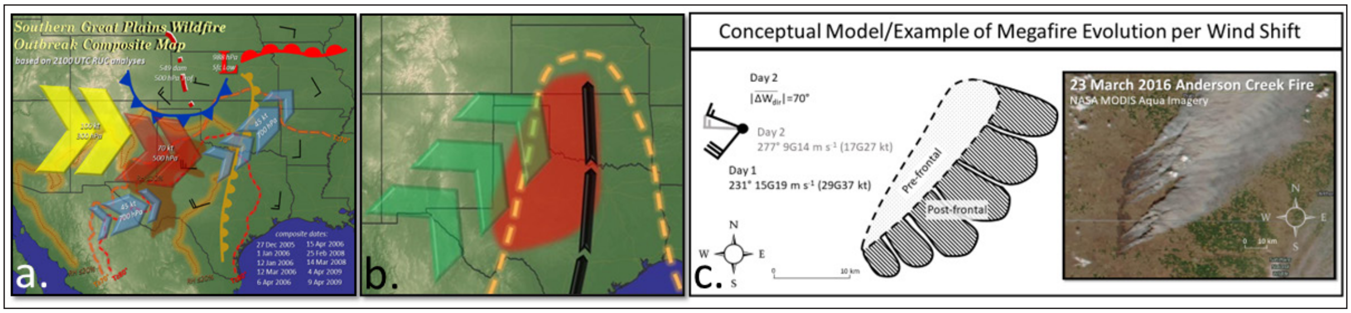

Figure 5a-c. Modern conceptual models for a) SGPWOs, b) fire-effective LLTR, and c) megafire evolution associated with wind shifts.

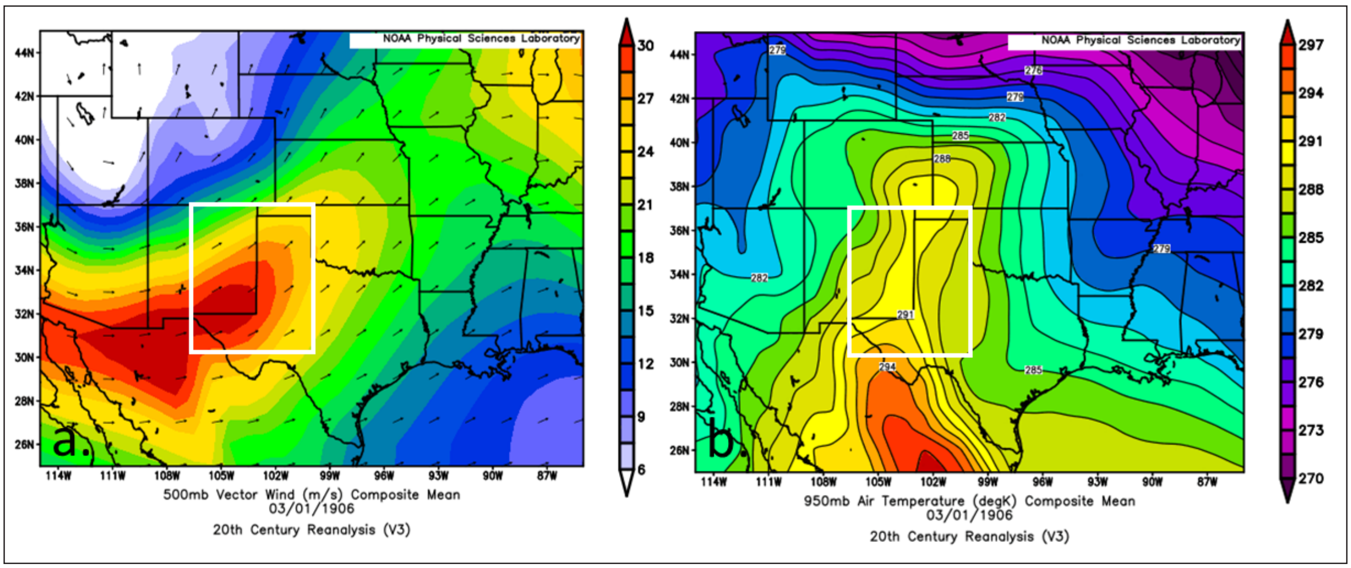

Figure 6a-b. NCEP/NCAR 20th Century Reanalysis Daily Composites valid 1 March for a) 500 hPa vector wind and b) 950 hPa air temperature. The most fire-effective alignment of these features is denoted (white box).

between Roswell, New Mexico, and Lubbock, Texas. Using daily mean 950 hPa RH and vector winds (Fig. 7a–c), we can infer a rapid east-northeast spread of the fire into Texas followed by subsequent eastward, and then southward expansion as winds veered toward the northwest with passage of the cold front (Fig. 8). A long flanking fire (10s of km) that swells with multiple head fires during a cold front-associated wind shift matches the modern conceptual model for plains megafire evolution (Lindley et al. 2019) during SGPWOs.

The Smokehouse Creek Fire, which evolved in a very similar fashion, is deemed to represent a useful reference analog. Expansion and smoothing of that fire's perimeter shapefile was used to provide a scale visualization of the March 1906 megafire in New Mexico and west Texas (Fig. 9). To remain true to the estimated fire dimensions reported in Rickard (1934) and Pyne (1982) of "150 miles long", "ten to sixty miles wide" and "over 6 million acres" respectively, we manipulated the Smokehouse Creek Fire perimeter to measure 270 km (168 miles) along its major axis, an average of 90 km (56 miles) in width with post-frontal southward swells extending 140 km (87 miles) to achieve a burn area of 24 768 km^2 (6 120 306 acres).

The secondary fire coincident with the >6 million-acre blaze of March 1906 which reportedly impacted Lubbock, Garza, and Lynn Counties, Texas, is described to have burned "about six hundred sections" (~1554 km^2 or 384 000 acres) and was additionally influenced by the same wind shifting cold front (Rickard 1934). Based on this description, the fire perimeter shapefile for the 1732 km^2 (427 987 acre) Highway 152 megafire associated with the 12 March 2006 East Amarillo Complex was manipulated as a reference. The Highway 152 Fire similarly made a south turn due to a northwesterly wind shift, and was smoothed and clipped here to a representative 1557 km^2 (384 743 acres).

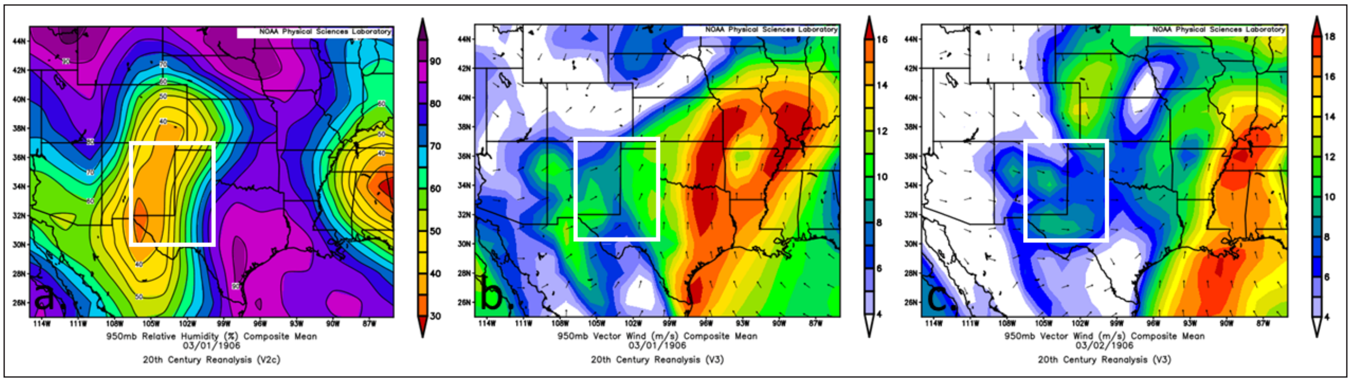

Figure 7a-c. NCEP/NCAR 20CR Daily Composites valid 1 March for a) 950 hPa relative humidity (only available in V2c), b) 950 hPa vector wind, and c) 2 March 950 hPa vector wind.

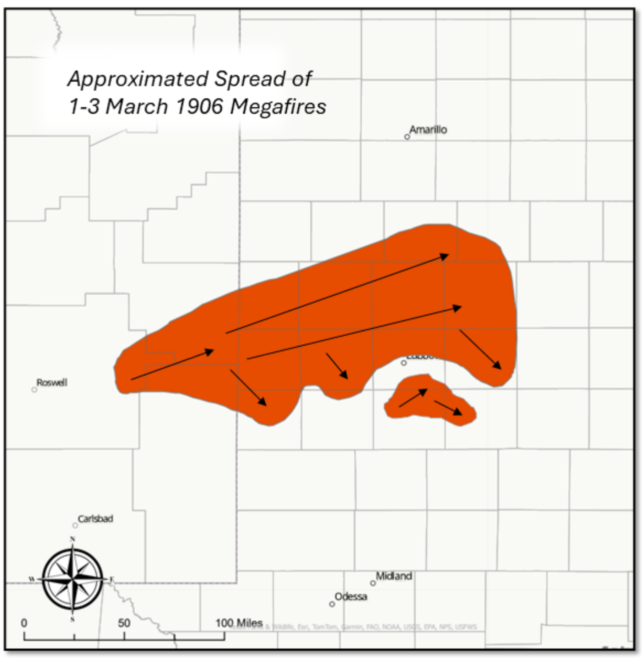

Figure 8. Approximated spread of the 1906 megafires as hypothesised in the reanalysis.

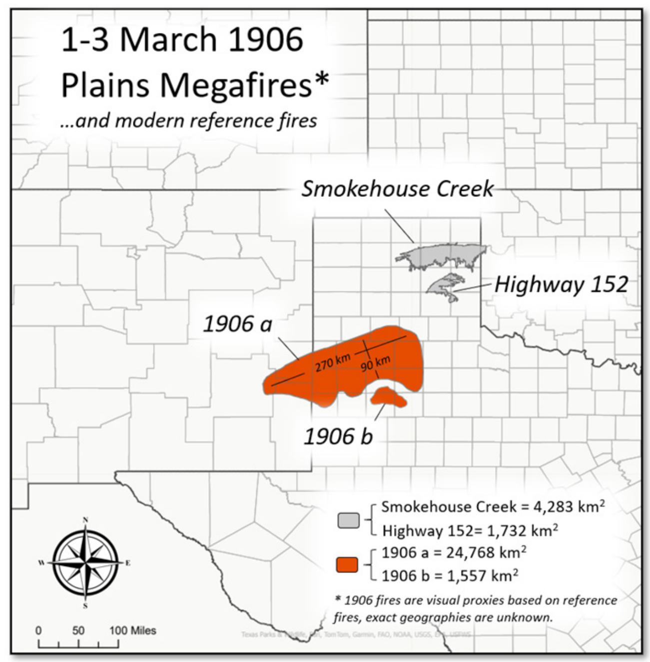

Figure 9. Projection of the 1–3 March 1906 megafires shown with their respective modern reference fires used as original shapefiles.

While the proxy reanalysis presented has inherent limitations, we primarily provide modern fire practitioners with a visual scale comparison of the recent Smokehouse Creek Fire relative to a historically massive blaze from the region's past. Synoptic-scale estimates of the 1–3 March 1906 atmospheric state via 20CR are, however, consistent with observations and science-based conceptual models used in predictive methods for high-impact wildfire episodes today. It is important to emphasize that the escalating conflagrations on the southern Great Plains in recent decades have historical precedence dating back more than a century, and as demonstrated here, similar atmospheric features and processes were at play. This serves as evidence that the parent weather systems are ever-present and conditionally fire-effective, but ignition sources and means of fire spread through available vegetation has likely varied on generational time scales.

In addition to corroborating historic fire-effectiveness of critical fire weather patterns that are known to be problematic today, there also are modern applications in fire, land, and emergency management operations. The ability for individual fires to achieve a size >24 281 km^2 (>6 million acres) on the Southern

Great Plains seems extremely unlikely today. Albeit, burns of the same spatial order of magnitude seemed only remotely plausible prior to the 2024 Smokehouse Creek Fire. Current predictive services that guide preparedness actions are increasingly partnered and focused on the holistic multi-disciplinary fire environment. Satellite-aided fire detection and remote sensing coupled with modern telecommunication networks provide both advanced preparedness and real-time notification of emerging wildfires on the landscape. Both firefighting personnel and equipment are far more advanced than those available in the early 20th Century, and emerging technologies continue to increase their effectiveness and efficiency. Further, the ambient plains fuelscape is now more accessible and fragmented by transportation infrastructure and agricultural practices. Yet, both incident first responders and meteorologists regularly refer to past experience in order to gauge future potential. Thus, the relatable contextual review provided of this particular historic event furthers strategic assessment and preparedness. The recent occurrence of a modern plains gigafire (i.e., Smokehouse Creek), however, affirms that the southern Great Plains is advancing toward a resurgent 'fire age' (Pyne 2021). Now, however, there are immensely more values-at-risk on the landscape compared to a century ago. As such, complex SGPWOs that involve multiple simultaneous megafires, or mega-firestorms, such as the March 2006, March 2017, and February 2024 outbreaks, will continue to present an escalating threat across the region.

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