Science to Service: An Interagency Approach to Wildfire Forecast/Warning Services on the Southern Great Plains
“If an agency stays only within its jurisdictional boundaries, it will fail. [we must] address how fire really exists, and not how select sciences can handle it”  

- Dr. Stephen J. Pyne
Southern Great Plains Wildfire Outbreaks (SGPWO)

- 37 SGPWOs
- 7.03 million acres
- 3,454 structures lost
- 44 killed, 305 injured
- Dec 2005-Apr 2023

“A ‘perfect storm’ for extreme fire.”

Texas A&M Forest Service

Dec 2005-Apr 2023

- 37 SGPWOs
- 7.03 million acres
- 3,454 structures lost
- 44 killed, 305 injured

84% of SGPWOs result in human casualties
Dec 2005 – Apr 2006 SGPWOs
Application of rudimentary science to the Plains fire problem analogous to severe storm forecasting in the 1950s
Predictable Synoptic Pattern for Fire

SGPWOs result from the same parent weather systems as severe storms.
9 April 2009 – A Pivotal Fire Disaster

29 fires
235,792 acres
339 structures lost
4 killed, 35 injured
Intense surface heating along the low level thermal ridge creates enough atmospheric instability to tap into the extreme winds blowing in the mid levels of the atmosphere.
“There is a combination of fire weather and fuel conditions that combine to produce regional wildland fire outbreaks

The legacy of the April 9th outbreak may be that we are better able to narrow or quantify the area of higher risk for significant fire occurrence”

SGPWO Working Group Stated Goal:

“Three day advanced notice”
Working Group for Decision Support

29 Peer-Reviewed & Conference Publications

Applied Operations-to-Research-to-Operations
Working Group for Decision Support

History of the SGPWO Working Group

Conceptual models are a basis for quantified fire environment analyses relative to historic fire occurrence.
"It is crucial that we take steps to prepare for and respond to extreme wildfires"…Governor Rick Perry 2/25/11
Red Flag Warnings tend to be a “one size fits all” forecast for wildfires. A collaborative, probabilistic fire environment forecast can yield more precision on where high impact wildfires are most likely to occur and ultimately support decisions for movement of limited suppression resources.
Summary of Probabilistic Outlooks

Probability of Significant Wildfire Occurrence – 15 December 2021

Risk Potential Legend

- <10%: Nil and/or Routine Fire Wx with Initial Attack & Large Fire
- 10%-30%: Low-Moderate Significant Fire
- 40%-60%: High Significant Fire Potential - Outbreak Possible
- >60%: Significant Wildfire & Outbreak Likely
Pieces of a Probabilistic Puzzle

- Energy Release Component
- Red Flag Threat Index
- Ensemble High-resolution Models
- CIPS Analog Guidance
- Weather + Fuel Parameter Space
‘Critical Fire Weather’ Does Not Fit in a Box

- Most focused on perceived ‘critical’ thresholds of humidity and wind.
- Strict adherence to these thresholds have led to fire disasters occurring outside of Red Flag Warnings.

Wildland Fire is Non-Deterministic by Nature
Total Fire Environment

ERC\textsuperscript{2} Classes + RFTI = Headline Recommender

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<th>Weather (RFTI) + Fuels</th>
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<th>Elevated (1-2)</th>
<th>Near Critical (3-4)</th>
<th>Critical (5-6)</th>
<th>Extreme (7-8)</th>
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FIRE-EFFECTIVE WEATHER IS A MOVING TARGET!
Red Flag Threat Index in Hi-Res Weather Models

TTU WRF RFTI

GOES-16 3.9u

*Issues: Initial attack fires were excluded due to occurrence outside of the TTU WRF RFI domain.*
GOES-R Revolutionary Tool

- Kincade Fire visually evident in GOES-17 data 52 sec after ignition

- GOES fire algorithms triggered 3-5 minutes later

- 70-80% of NWS ‘hot spot notifications’ in OK & KS received prior to local 911 dispatch!

“manual monitoring of raw GOES-16/17 data…provides opportunities for earlier notification of wildland fire ignition…compared to those provided by current automation processes.”
Adapted for fire from Dr. Heather Lazrus (NCAR) & NSSL FACETs
Vegetative fuels are the biospheric response to climate & weather.

"Fire is what its circumstances make it. It synthesizes its surroundings. Wildfires become damaging when they burn outside normal constraints and in rare combinations of fuel and weather that are naturally short-lived. Big fires require many environmental coincidences." Pyne 2012, 2015, 2019, 2020

"There will be no fire unless weather and fuels are right." Dr. Pyne, 1982
SGPWO Working Group 25-27 March 2023:

“Run-to-run continuity with the next major short wave trough to eject across the Plains. The best atmospheric alignment will occur along eastern periphery of recent drying. ERC percentiles increase to around 75th%ile by Friday”
"Primary concern Friday revolves around severity of fire weather that will impact central OK around midday with opportunity for fire ignition/problematic behavior in proximity to population centers. This will present a notable WUI risk from OKC to Tulsa."
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"Conditions will rapidly degrade through 3 pm yielding increasing risk of problematic wildfires. The potential exists for new fire starts to outpace local jurisdiction resources and for evolution of damaging/dangerous wildfires."
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25-31 March 2023 – SGPWO Engagement

Participants
- 6 NWS WFOs
- 2 NWS Regional Centers
- NWS HQ
- Southern GACC
- NICC
- OFS/TAMFS/KSF

- 308 Substantive Posts
- 12 Probabilistic Outlooks
Probabilistic Ensemble Analogs

CIPS GEFS SGPWO Guidance locked in on a high-confidence forecast for a SGPWO candidate weather system at 126 hours. The #1 indicated analog was the 11 November 2015 SGPWO which burned 47,000+ acres in northeastern Oklahoma and southeastern Kansas.

At the time of its occurrence, the 11 November 2015 SGPWO was one of only 3 outbreaks in the Working Group’s history that was not forecasted.
Measures of Success

Verification of SGPWO Working Group Probabilistic Outlooks 2011-2022

Average Lead Time (2011) = 2 days
Average Lead Time (2022) = 5 days

“Moving Metal, Men & Money”
Brad Smith – TA&MFS

“Proactive vs. Reactive”
Drew Daily – OFS
After the fire disaster in Paradise, meteorologists mull how to improve warning system

“Underscores the need for a short-fused Weather Service product – one that encompasses a small area, like a tornado warning, and elicits the same level of urgency through the EAS.”

By Matthew Cappucci
November 28 at 12:43 PM
FRWs are governed by NWSI 10-518 (Non-weather Emergency Messages) & addressed in 10-401 (Fire Weather Service Product Specification):

“time-critical, life- or property-saving emergency information from federal, state, tribal, and local officials…evacuation of areas in the fire’s path may be recommended by authorized officials according to state law or local ordinance”

“important that WFOs provide detection and warning products for active fires (Fire Warnings and Civil Emergency Messages for fire) under the explicit auspices of external (non-NWS) fire control or emergency management authorities”

In Practice – only issued upon local EM requests when evacuations are in progress.
Science-based Operational Guidance

The scientific guidance for Fire Warnings was co-developed between meteorologists and fire analysts through simulations & analyses, and includes:

- Gridded environmental information (ERC percentiles & Red Flag Threat Index).
- Remote sensing (GOES-16/17) signals related to past extreme fire behavior in various fire environments.
Legacy FRW Practices

Timeline of NWS Norman-OFS Communication Prior to Fire Warning Issuance

- NWSI 10-518 permits Fire Warning issuance at request of state/local/tribal officials.
- In practice, only issued upon request of local EM during evacuations.
- Adherence to this practice delayed warning issuance 82 minutes after “life threatening” fire identified per TAMFS/OFS/OUN science-based Fire Warning simulations.
- More timely Fire Warnings issued at request of state forestry agencies and collaborated between meteorologists/fire analysts are possible.

82 min Lapse
Integrated Fire Warning Procedure

Interdisciplinary Process for Collaborated Warnings

1. Pre-fire Environmental Coordination
   - OFS/TAMFS
   - OEM

2. NWS Meteorologist Identifies Candidate Fire
   - “Potentially Dangerous Fire Detected” Hotspot Notification
   - Details/Reasoning

3. OFS/TAMFS Corroborates Ground-truth Threat
   - On-site Resources
   - Local EM

4. OFS/TAMFS Responds With Request for Fire Warning Issuance
   - Yes
   - No
Integrated Fire Warning Procedure

1. Hot Spot Notification

Fri Mar 31 2023 13:47 CDT
Hot Spot
35.750/ 35 45.027N
-97.451/ 97 27.066W
4 miles SSE of Seward, OK.
Logan, OK
-Fire Wx Level: Critical
-Method: Satellite - 1 Min
-Ob: GUTH T: 77 Dpt: 22
RH: 13 WDIR: 242 WSPD: 32
WGST: 49 7.0 miles NNW of POL

31 March 2023
Integrated Fire Warning Procedure

1. Hot Spot Notification
2. ‘Potentially Dangerous Fire Detected’

Fri Mar 31 2023 14:06 CDT
Potentially Dangerous Fire Detected
35.763/35 45.776N
-97.446/97 28.746W
3 miles SE of Seward, OK.
Logan, OK.
-Fi re Wx: Level: Extreme
-Method: Satellite - 1 Min.
-Cb: KOCX: 1:75 Dpt: -10 RH: -15N
- A WRFR-270 WSPD:44
- WGST: 61.2 miles NNE of POL.
Fire 3 se of Seward is now at
123 deg C and sustaining at
greater than 100 deg c. To
request Fire Warning contact
WFO Norman.

31 March 2023
Integrated Fire Warning Procedure

1. Hot Spot Notification
2. ’Potentially Dangerous Fire Detected’
3. OFS-WFA Spread Model – Affirmative Warning Decision

31 March 2023
Integrated Fire Warning Procedure

1. Hot Spot Notification
2. ‘Potentially Dangerous Fire Detected’
3. OFS-WFA Spread Model – Affirmative Warning Decision
4. FRW Issued
Integrated Fire Warning Procedure

1. Hot Spot Notification
2. ‘Potentially Dangerous Fire Detected’
3. OFS-WFA Spread Model – Affirmative Warning Decision
4. FRW Issued

31 March 2023
Integrated Fire Warning Procedure

31 March 2023

55 Homes/156 Outbuildings Destroyed

NO FATALITIES
BULLETIN - EAS ACTIVATION REQUESTED
Fire Warning
REQUESTED BY OKLAHOMA FORESTRY SERVICES
Relayed by National Weather Service Norman OK
211 PM CDT Fri Mar 31 2023

The National Weather Service in Norman has issued a
Fire Warning at the request of Oklahoma Forestry Services for
southern Logan County.

* At 200 PM CDT, a dangerous wildfire was located 6 miles north of
  Edmund, or 3 miles southeast of Seward, moving rapidly east at 3
to 5 mph.

* Areas impacted...Interstate 35 between Edmund and Guthrie.

* Additional Information...Smoke and fire will present a threat to
  life and property on Interstate 35 and for residents of the
  surrounding area of south-central Logan County.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Be prepared to evacuate quickly if requested and follow all safety
instructions from local emergency management officials. Do not drive
into smoke.

Firefighters and incident responders should anticipate extreme fire
behavior including a wind-driven and torching fire.

$5

LAT...LON 35°84'97.00 35°72'97.00 35°72'97.37 35°72'97.38 35°72'97.49
35°81'97.50

$5
Southern Great Plains Wildfire Outbreak Group

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