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The Development and a Summary of the Wildland Fire Emissions in the 2020 National Emissions Inventory

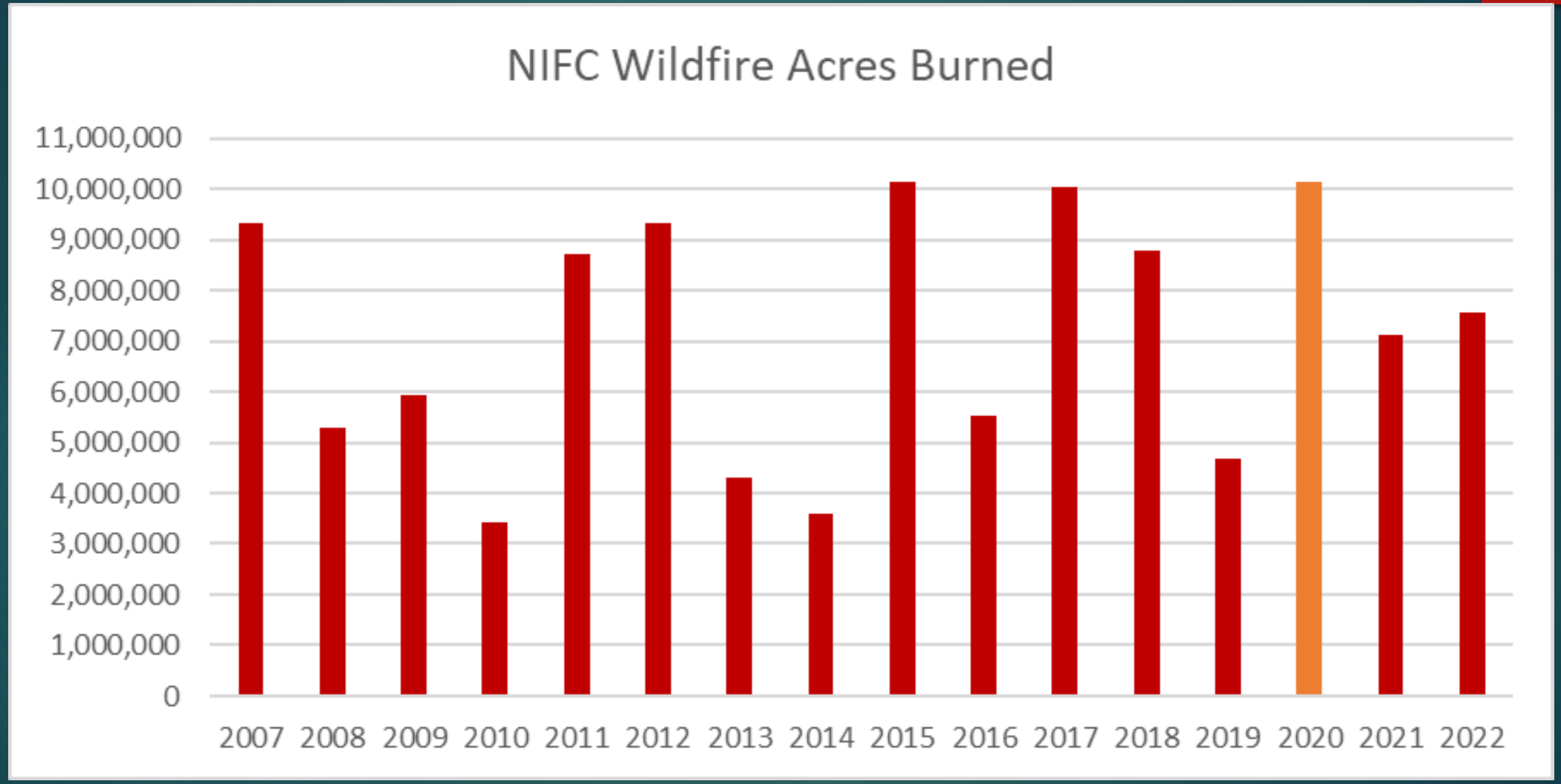
J VUKOVICH, USEPA/OAQPS/EIAG

SEP 27, 2023

2023 EPA EMISSIONS INVENTORY CONFERENCE

ACKNOWLEDGE: JAMES BEIDLER (ORD), GEORGE POULIOT (ORD) AND TESH RAO (OAQPS)

2020 Wildfire season: Very active



NIFC = National Interagency Fire Center

2020 Wildfire season: Top 10 fires

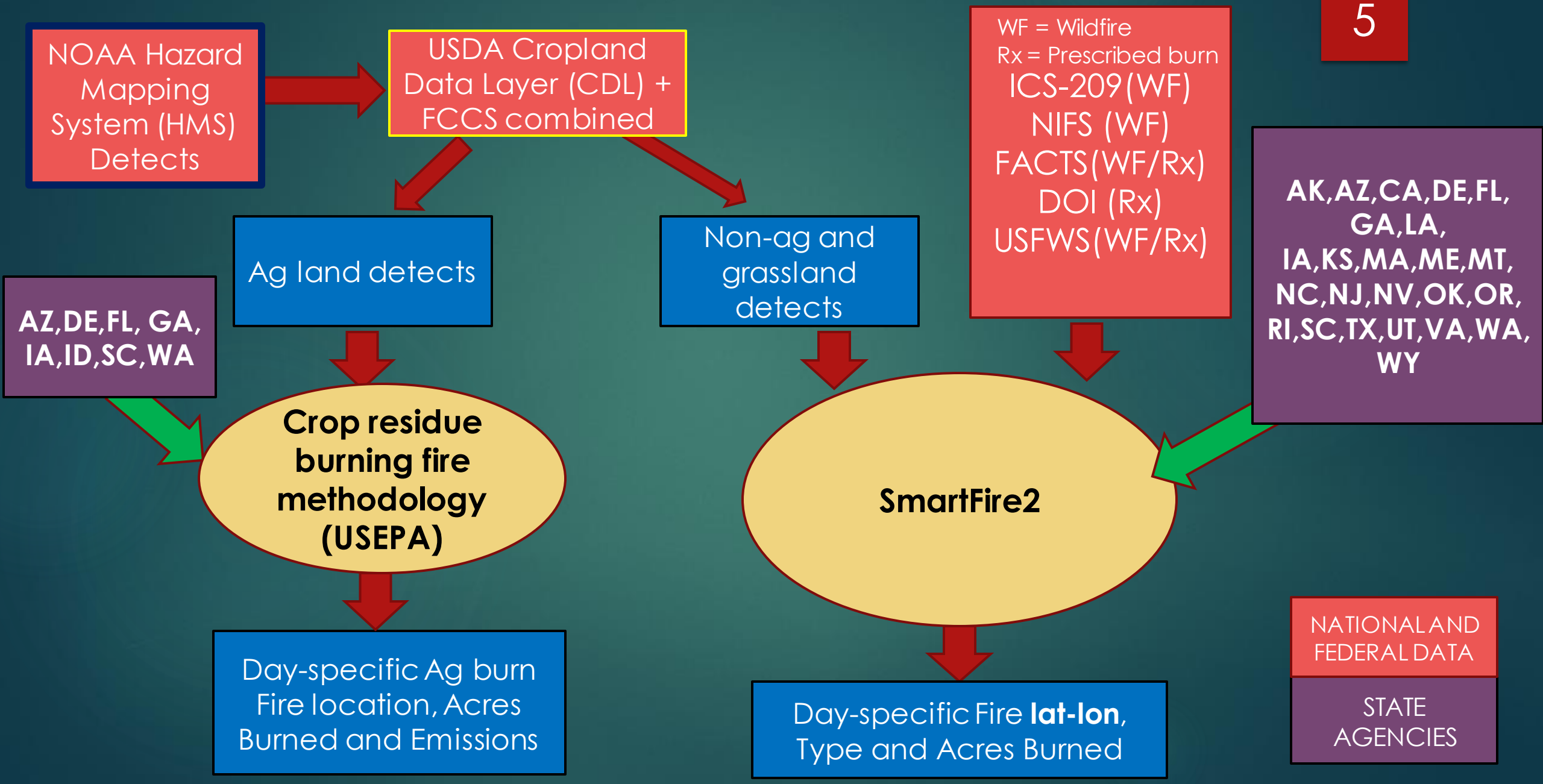
Name	State	Start Date	Contain or Last Report Date	Size (acres)	Estimated Cost
August Complex	CA	8/17	11/11	1,032,648	$115,511,218
SCU Lightning Complex	CA	8/16	9/14	396,624	$69,412,351
Creek	CA	9/4	12/17	379,895	$193,000,000
LNU Lightning Complex	CA	8/17	10/1	363,220	$94,646,381
North Complex	CA	8/17	12/2	318,935	$112,711,950
Pearl Hill	WA	9/7	9/15	223,730	$4,241,353
Cameron Peak	CO	8/13	12/4	208,913	$133,300,000
Lionshead	OR	8/16	11/12	204,469	$65,440,000
East Troublesome	WY	10/14	11/25	193,812	$15,682,681
Beachie Creek	OR	8/16	10/28	193,573	$29,838,526

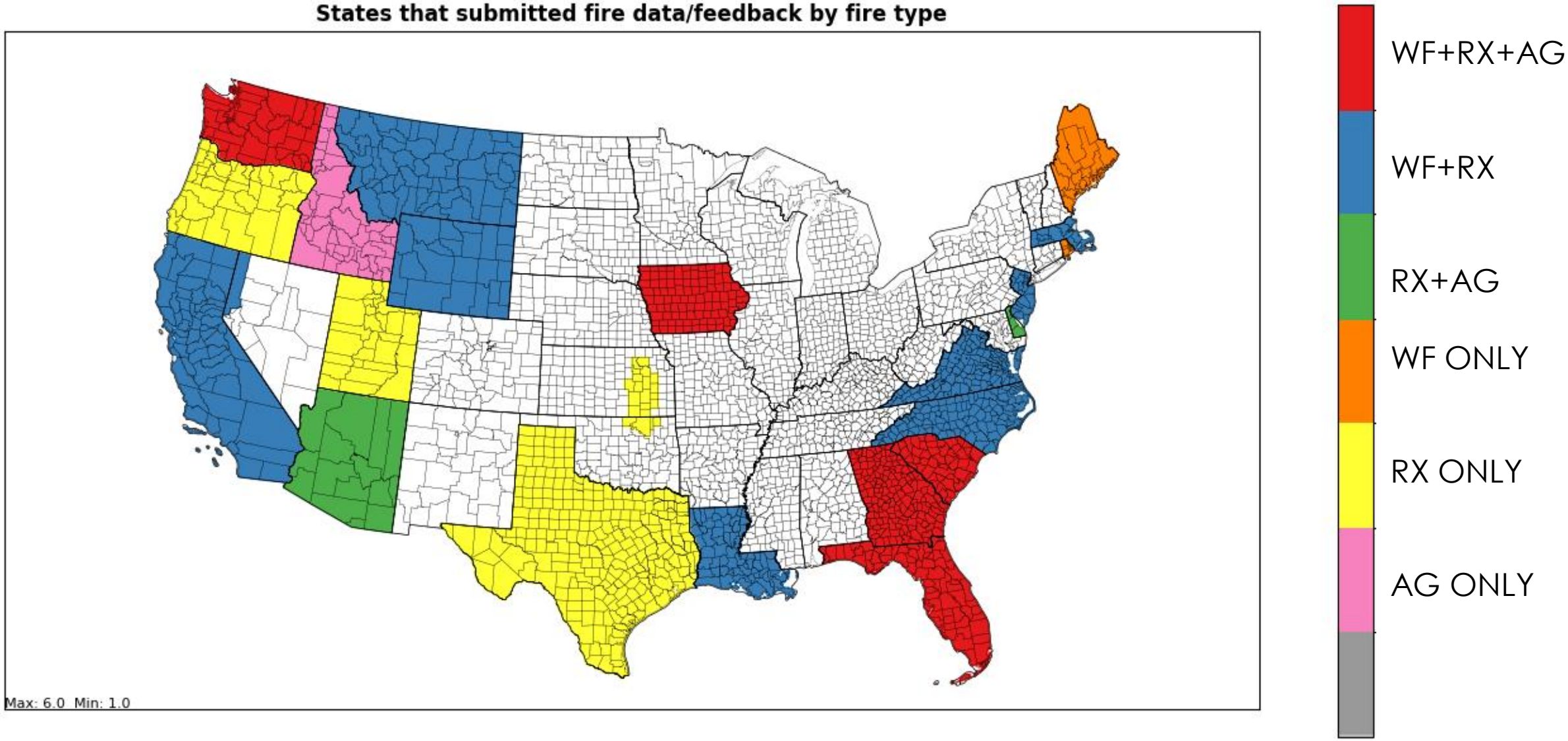
NIFC totals

NEI: Wildland Fire inventory

- National Emissions inventory (NEI) is developed by USEPA **every 3 years** for anthropogenic, fires and biogenic (vegetation) sources
- Produce **day-specific** emissions for prescribed burns and wildfires
- Emissions include Criteria Air Pollutants (CAPs) and Hazard Air Pollutants (HAPs)
  - Added Lead (Pb) this NEI cycle
- Uses available national and State/Local/Tribal (SLT) **activity databases** with satellite detects from Hazard Mapping System (NOAA/NESDIS)
- Uses Smartfire2 to reconcile detects with all activity databases to produce daily acres burn by fire type (wildfire and prescribed only)
- 2020 NEI used US Forest Service's Bluesky Pipeline to estimate emissions
- Emissions are provided for both flaming and smoldering phases

Smartfire2 and Agriculture burn processing for 2020 NEI

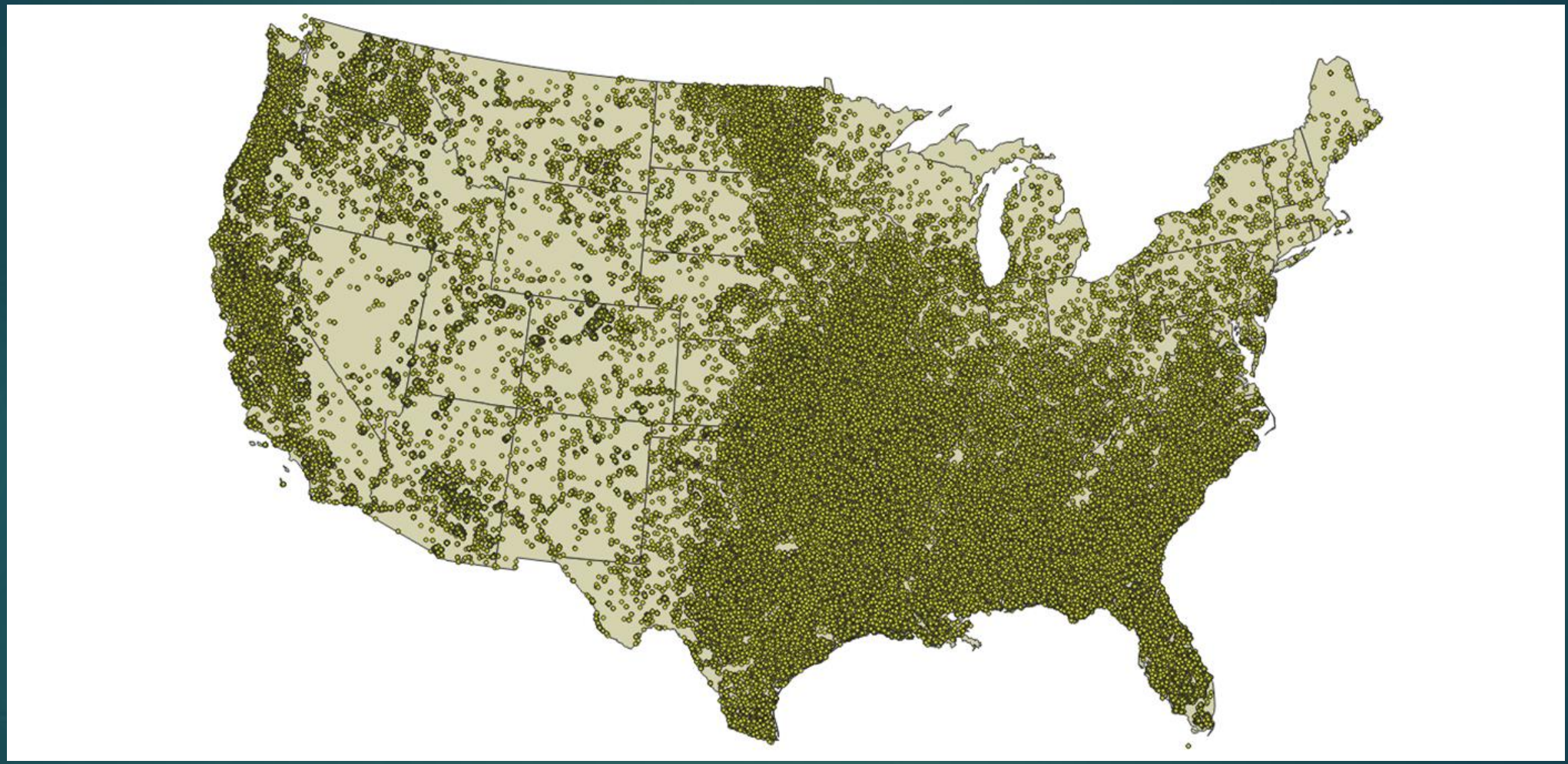



States that submitted fire data/feedback by fire type
Max: 6.0 Min: 1.0
WF+RX+AG
WF+RX
RX+AG
WF ONLY
RX ONLY
AG ONLY

New satellite product suites now available in HMS

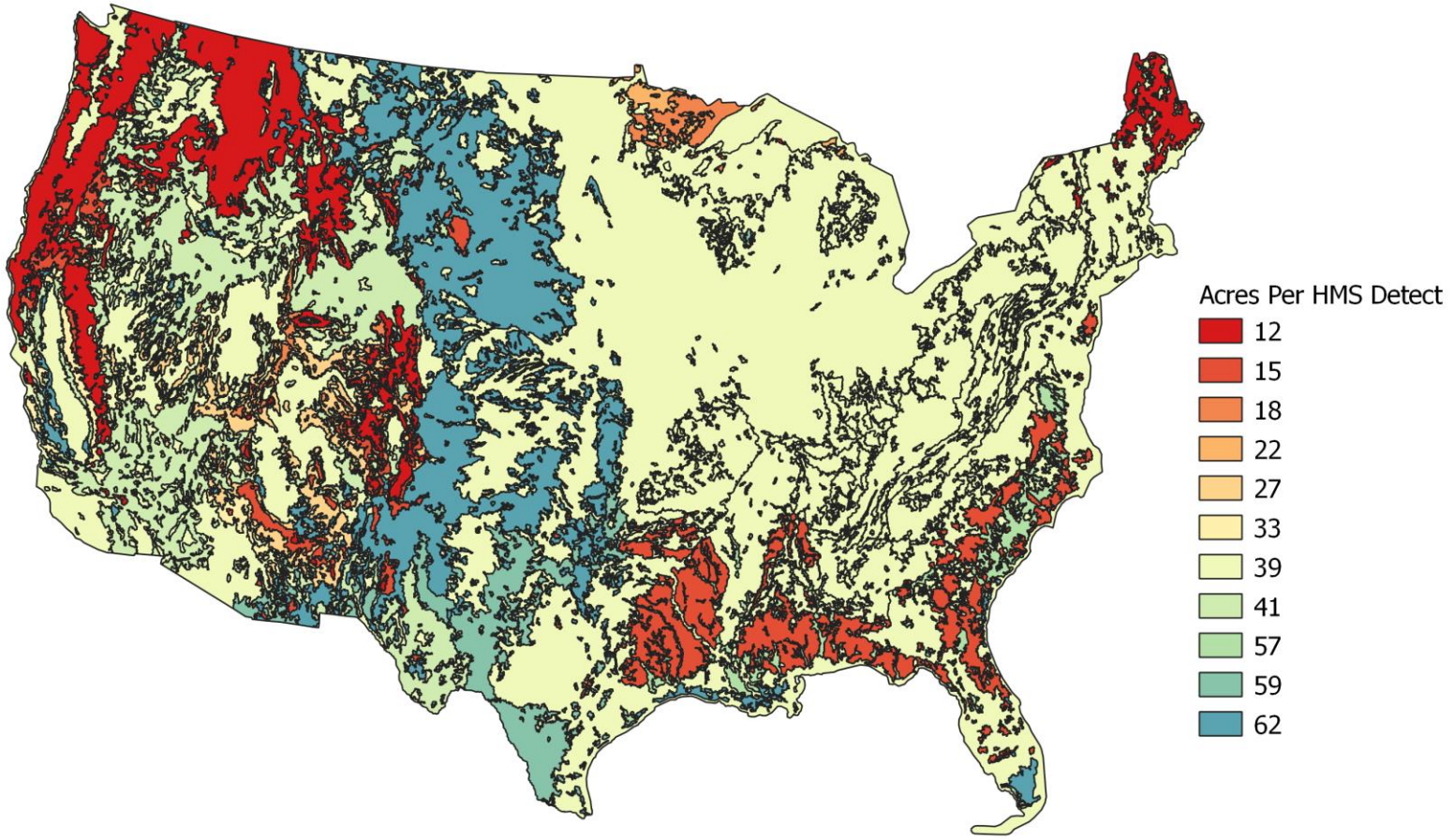
- NASA Suomi-NPP VIIRS Active Fire product suite
  - Two VIIRS active fire products are generated independently using the available 750 m and 375 m resolution data
  - VIIRS 375 m fire product provides greater response over smaller fires, as well as improved mapping of the perimeters of large fires
  - https://viirsland.gsfc.nasa.gov/Products/NASA/FireESDR.html
- GOES-R series Fire Detection and Characterization (FDC)
  - Advanced Baseline Imager (ABI) is capable of detecting heat signatures with improved time and space resolution, including smaller fires, compared to the previous GOES imager
  - https://www.goes-r.gov/education/docs/fs_fire.pdf
- Result is higher resolution product and more fires (HMS detects or pixels)
- For 2017NEI about 320,000 HMS detects input into SmartFire2
- For 2020NEI about 1,000,000 HMS detects input into SmartFire2

2020 HMS detects after filtering out Agricultural (CDL) detects



Default acres per HMS detect update to account for new satellites product suites (2)

2020 NEI Acres Per HMS Detect



Acres/pixel	Fuelbed
12	Closed_Conifer_Forest
15	Open_Conifer_Forests
18	Aspen
22	Boreal
27	Juniper
33	Pacific_broadleaved_Fores
39	Eastern_Deciduous_Forest
39	Other
41	Shrubland
57	Riparian
59	Savanna
62	Grassland

Situations where all we have is HMS satellite information

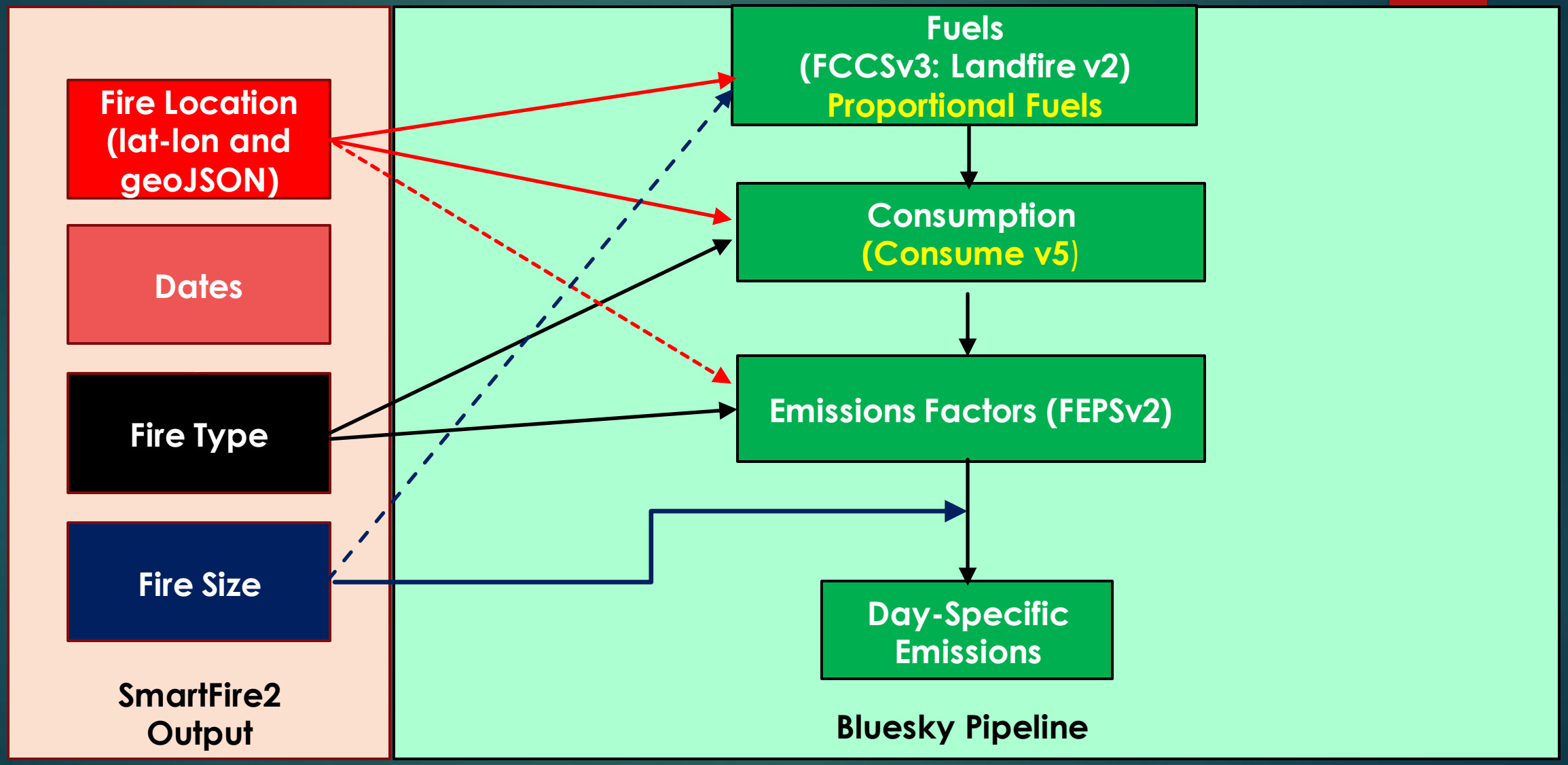
FIRE TYPE	ACRESBURNED	HMS_ONLY ACRESBURNED	RECONCILED WITH ACTIVITY ACRESBURNED	% HMS_ONLY ACRESBURNED
RX	12,134,855	**5,260,070**	6,874,785	**43.35%**
WF	10,309,880	305,653	10,004,227	2.96%
TOTAL	**22,444,735**	**5,565,723**	**16,879,012**	**24.80%**

TYPE	ACRESBURNED DRAFT VERSION
RX	12,658,064
WF	10,336,272
TOTAL	**22,994,336**

stid	st_name	type	HMS_ONLY ACRESBURNED	TOTAL ACRESBURNED	% HMS_ONLY ACRESBURNED
48	Texas	RX	1,412,055	1,530,896	92.24%
40	Oklahoma	RX	722,152	1,039,072	69.50%
1	Alabama	RX	552,420	673,865	81.98%
5	Arkansas	RX	368,964	410,213	89.94%
22	Louisiana	RX	325,530	389,916	83.49%
29	Missouri	RX	320,424	405,937	78.93%
28	Mississippi	RX	252,731	334,932	75.46%
20	Kansas	RX	229,895	2,653,259	8.66%
31	Nebraska	RX	128,413	129,177	99.41%
47	Tennessee	RX	121,905	128,903	94.57%

Bluesky Pipeline (BSP)

- USFS has significantly updated the Bluesky Framework and named the new system "Bluesky Pipeline"
- It is open source at https://github.com/pnwairfire/bluesky
- EPA has compared Framework vs Pipeline for year 2017
- EPA has applied BSP for various other years and projects
  - EQUATES time series
  - Other 2018 inventory work

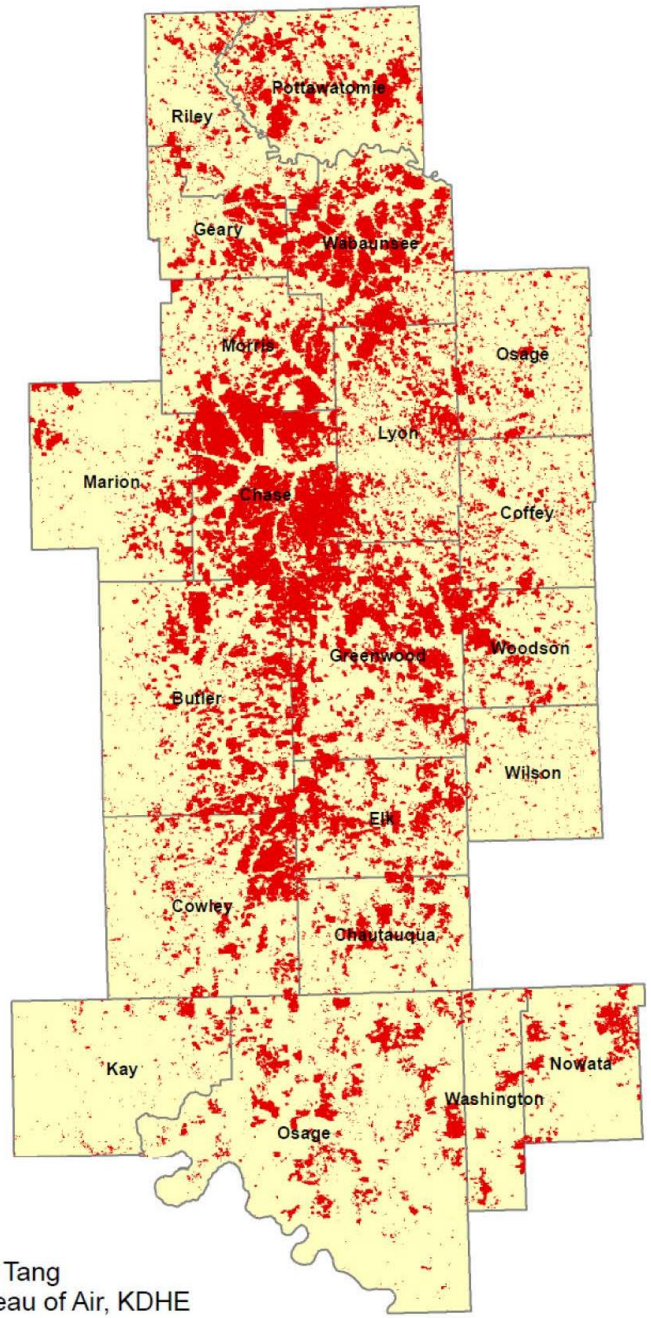


FCCS = Fuel Characteristic Classification System FEPS = Fire Emission Production Simulator

Estimating Area Burned Flint Hills Prescribed Burning Spring 2020

- Use all "Grass" HMS detects in these counties for the time of the prescribed Burning
- Calculate per county acres per HMS detect for this time period. Range 75-162 acres per detect
- 2020 Total number of Flint Hills Detects: 21,659
- Use SMOKE EMISSIONS REFERENCE APPLICATION (SERA) grass emission factors to estimate pollutants except PM2.5
- PM2.5 from measurements in Flint Hills Amara Holder (EPA-ORD): 12.68 g/kg

Flint Hills Acreage Burned (February 2 – April 30, 2020)



Counties	Acres Burned
Butler	237,628
Chase	343,359
Chautauqua	73,515
Coffey	61,330
Cowley	149,254
Elk	139,926
Geary	70,998
Greenwood	296,671
Lyon	159,231
Marion	83,909
Morris	147,293
Osage (KS)	61,870
Pottawatomie	139,385
Riley	74,395
Wabaunsee	231,820
Wilson	22,997
Woodson	70,890
Nowata (OK)	51,970
Osage (OK)	181,549
Washington (OK)	27,182
Kay (OK)	24,031
Total	2,649,203

** Denotes county was partly or completely covered by clouds during latest analysis.*

Yao Tang
Bureau of Air, KDHE

National totals

	2020NEI RX (emis in tons)	2020NEI WF (emis in tons)	2020NEI total	% contrib from wildfires
ACRESBURNED	12,187,458	10,275,666	22,463,124	45.7%
CO	8,366,798	19,619,163	27,985,961	70.1%
VOC	1,932,075	4,622,479	6,554,554	70.5%
PM10	907,413	1,976,972	2,884,385	68.5%
PM2_5	777,752	1,675,474	2,453,226	68.3%
CH4	393,194	955,476	1,348,671	70.8%
NH3	134,272	321,549	455,820	70.5%
NOX	148,642	246,229	394,871	62.4%
SO2	71,149	140,855	212,005	66.4%

NIFC Wildfire acres burned = 10,122,336

stid	state	fire type	annual total
2	Alaska	RX	79,966
2	Alaska	WF	178,948
15	Hawaii	RX	9,362
15	Hawaii	WF	14,166

National totals by phase (tons)

	WF residual smoldering	WF flaming	WF % flaming	RX residual smoldering	RX flaming	RX % flaming	Total (tons)
CO	5,523,216	14,095,947	72%	1,503,130	6,863,669	82%	27,985,962
VOC	1,288,660	3,333,819	72%	340,485	1,591,590	82%	6,554,555
PM10	515,899	1,461,073	74%	141,248	766,166	84%	2,884,386
PM2_5	437,205	1,238,269	74%	120,005	657,747	85%	2,453,226
CH4	259,393	696,083	73%	70,383	322,811	82%	1,348,671
NH3	89,647	231,902	72%	23,791	110,481	82%	455,821
NOX	23,872	222,358	90%	7,076	141,566	95%	394,872
SO2	25,762	115,093	82%	7,164	63,985	90%	212,005

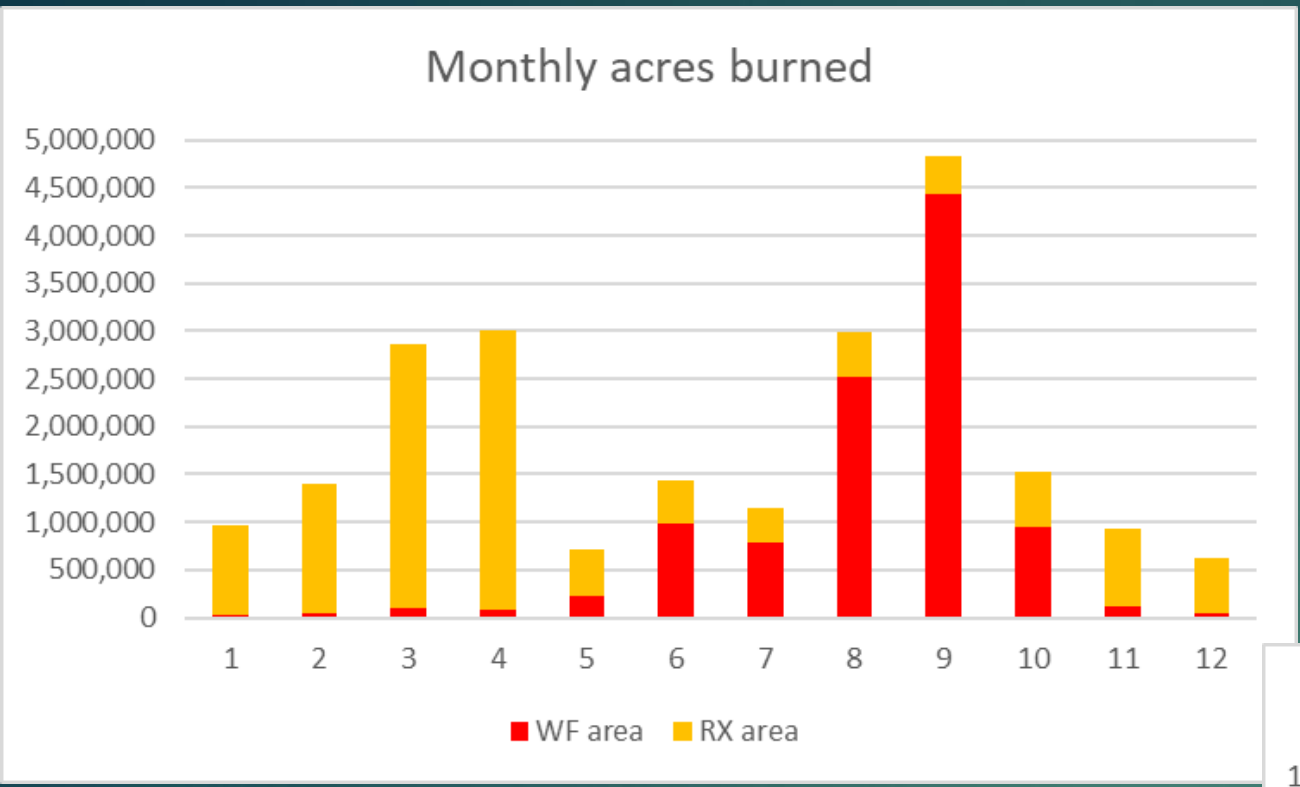
Top 15 State totals by Acres Burned

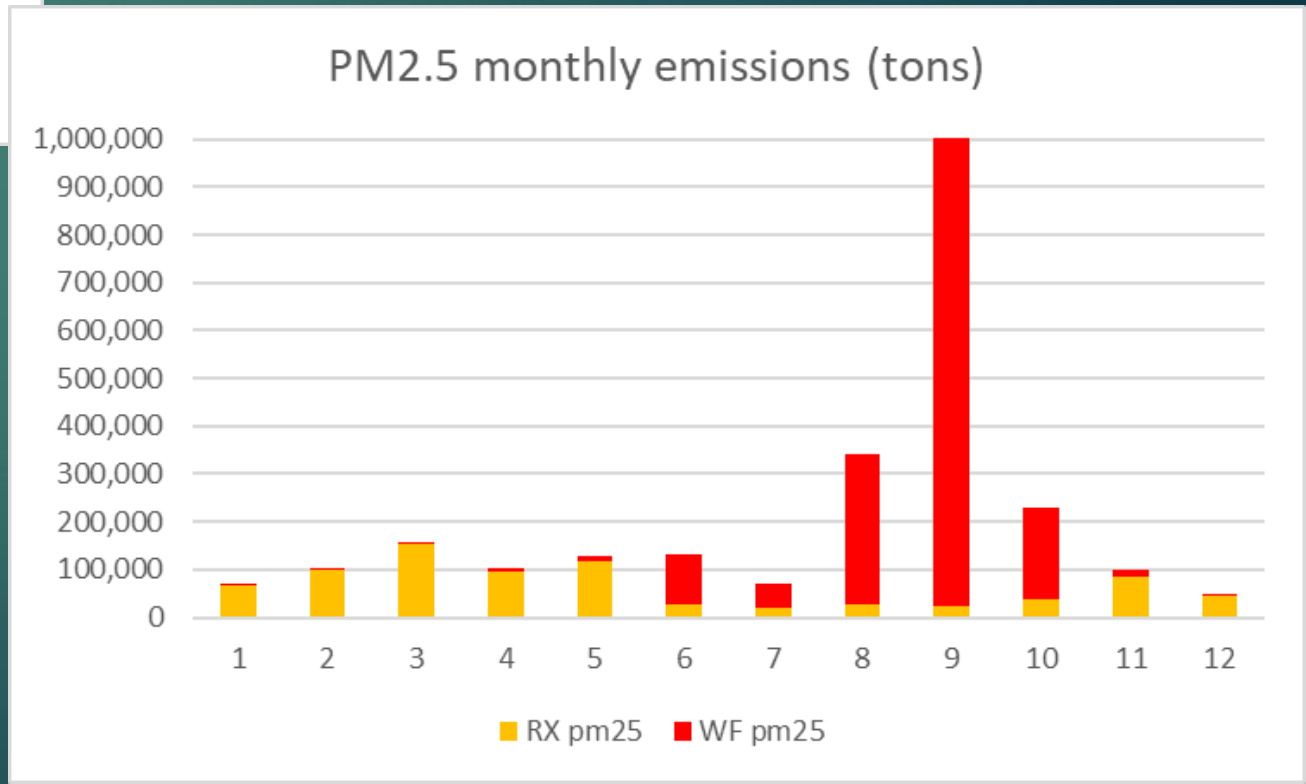
Wildfire totals: emissions in tons

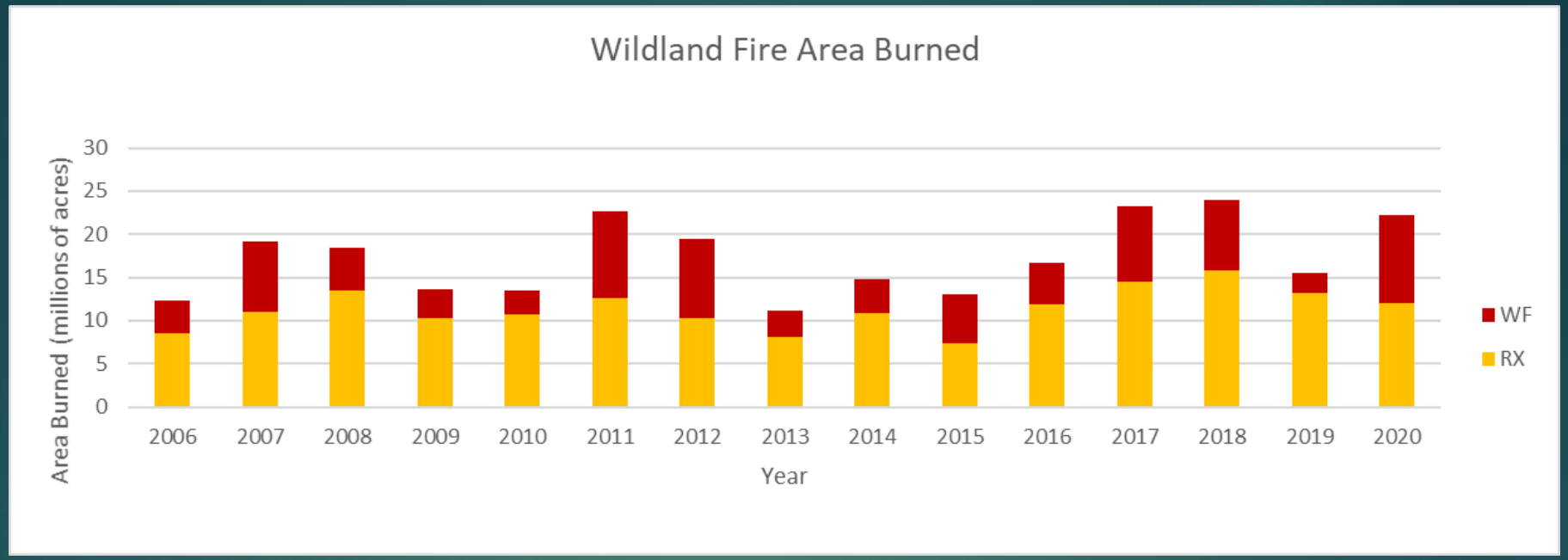
State	ACRESBURNED	CO	NOX	PM2_5	VOC
California	4,124,077	6,437,519	97,711	562,456	1,521,566
Oregon	1,101,771	6,810,602	70,069	569,847	1,600,448
Arizona	990,864	541,073	10,019	48,642	128,392
Washington	843,176	512,337	7,866	44,832	121,121
Colorado	707,261	1,850,393	19,390	155,091	434,929
Montana	342,310	313,984	4,678	27,367	74,189
Idaho	337,629	693,126	7,832	58,525	163,076
Wyoming	323,747	418,662	5,404	35,860	98,689
Utah	310,404	491,744	5,219	41,266	115,602
Nevada	254,927	70,954	1,506	6,524	16,890
Texas	209,546	80,902	1,577	7,332	19,219
Alaska	178,948	946,059	6,481	76,696	221,410
New Mexico	155,002	146,932	2,197	12,812	34,719
Florida	113,112	79,496	1,816	7,407	18,960
Oklahoma	87,444	62,448	1,305	5,727	14,860

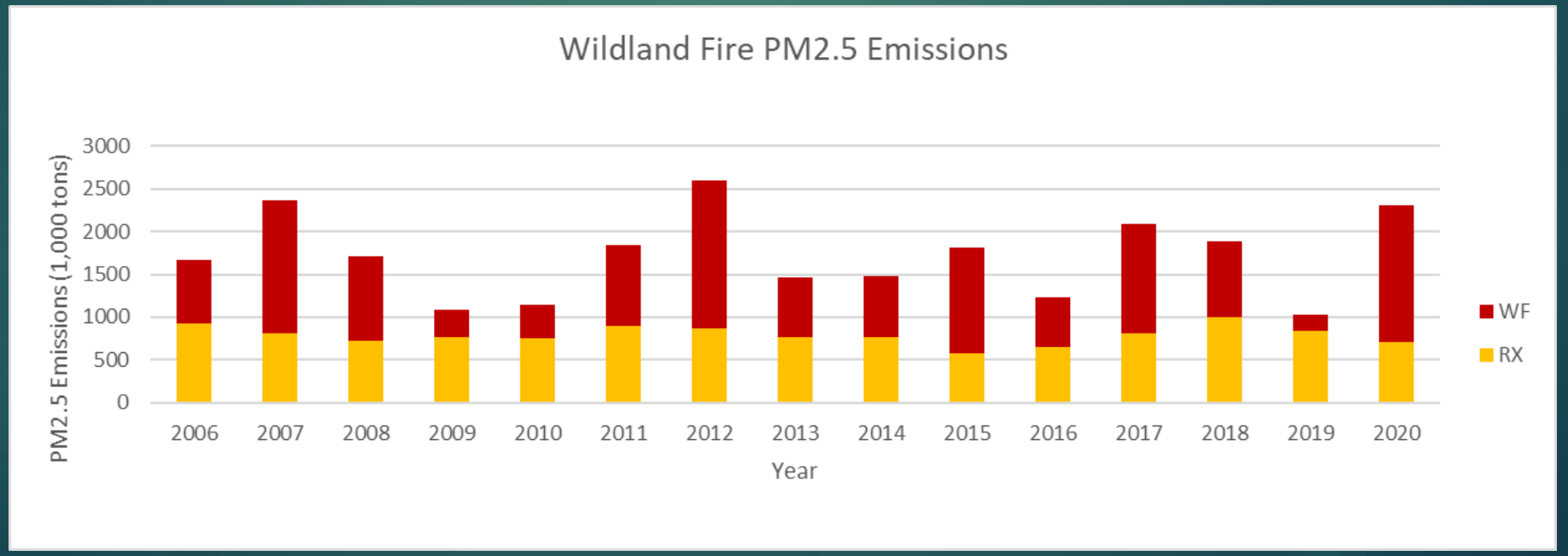
Prescribed totals: emissions in tons

State	ACRESBURNED	CO	NOX	PM2_5	VOC
Kansas	2,653,259	418,824	16,617	64,440	124,264
Texas	1,524,632	943,341	15,097	83,011	223,185
Florida	1,386,808	1,057,756	20,413	95,716	251,227
Georgia	1,127,083	439,516	13,264	48,536	26,862
Oklahoma	1,039,072	499,243	11,292	48,794	121,675
Alabama	673,865	487,754	10,350	44,846	116,108
Arkansas	410,213	465,388	7,687	41,133	110,173
Missouri	405,937	403,223	6,495	35,979	95,930
Louisiana	389,916	362,528	6,071	32,105	85,846
Mississippi	334,932	213,879	4,623	19,729	50,937
South Carolina	314,268	212,629	4,006	19,167	50,474
Iowa	164,596	74,202	1,495	7,403	18,356
Oregon	162,152	556,079	5,181	46,119	130,524
California	159,448	106,598	1,735	9,402	25,228
Nebraska	129,177	89,117	1,422	7,840	21,084

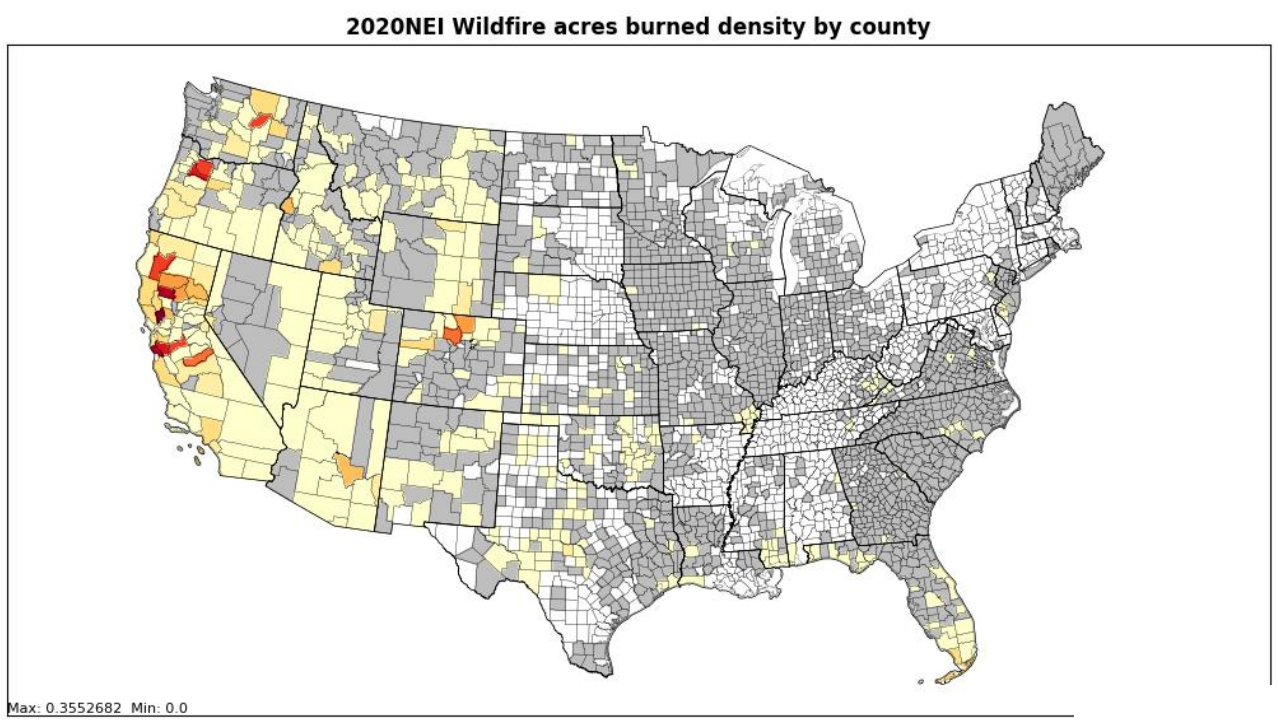

Monthly acres burned
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1
2
3
4
5
6
7
8
9
10
11
12
WF area
RX area


PM2.5 monthly emissions (tons)
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1
2
3
4
5
6
7
8
9
10
11
12
RX pm25
WF pm25

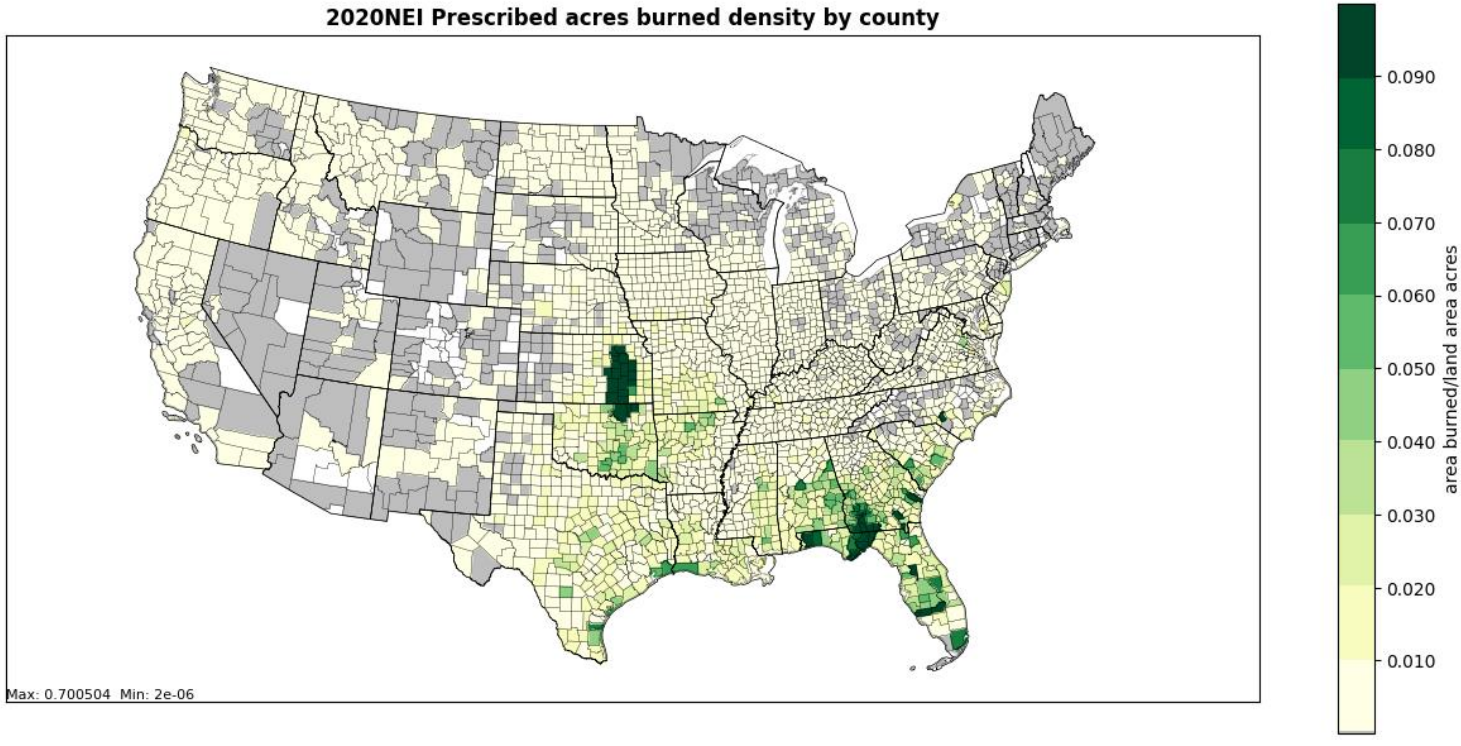




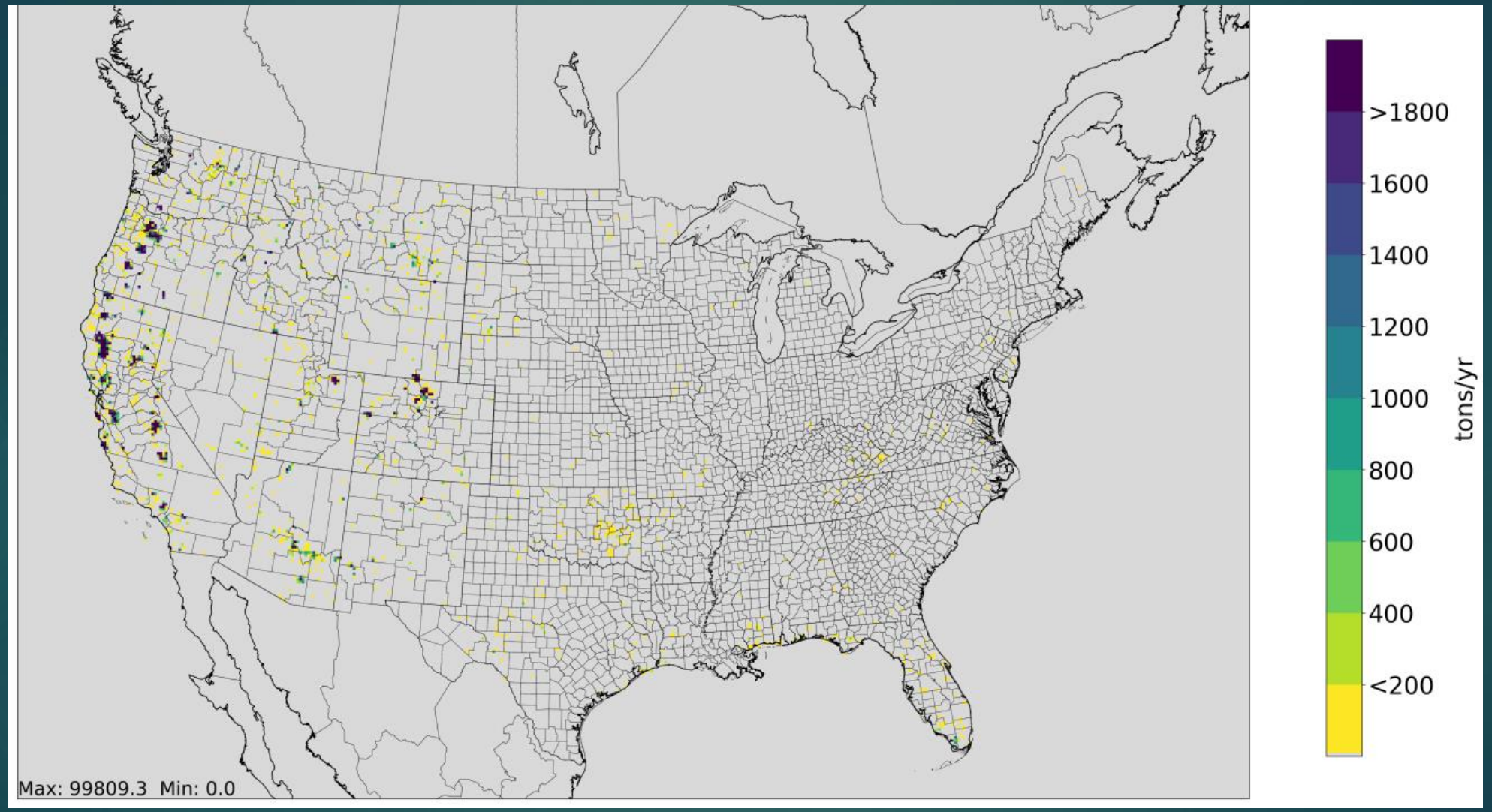
Graphs do not include Alaska fires


2020NEI Wildfire acres burned density by county
Max: 0.3552682 Min: 0.0
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
area burned/land area acres

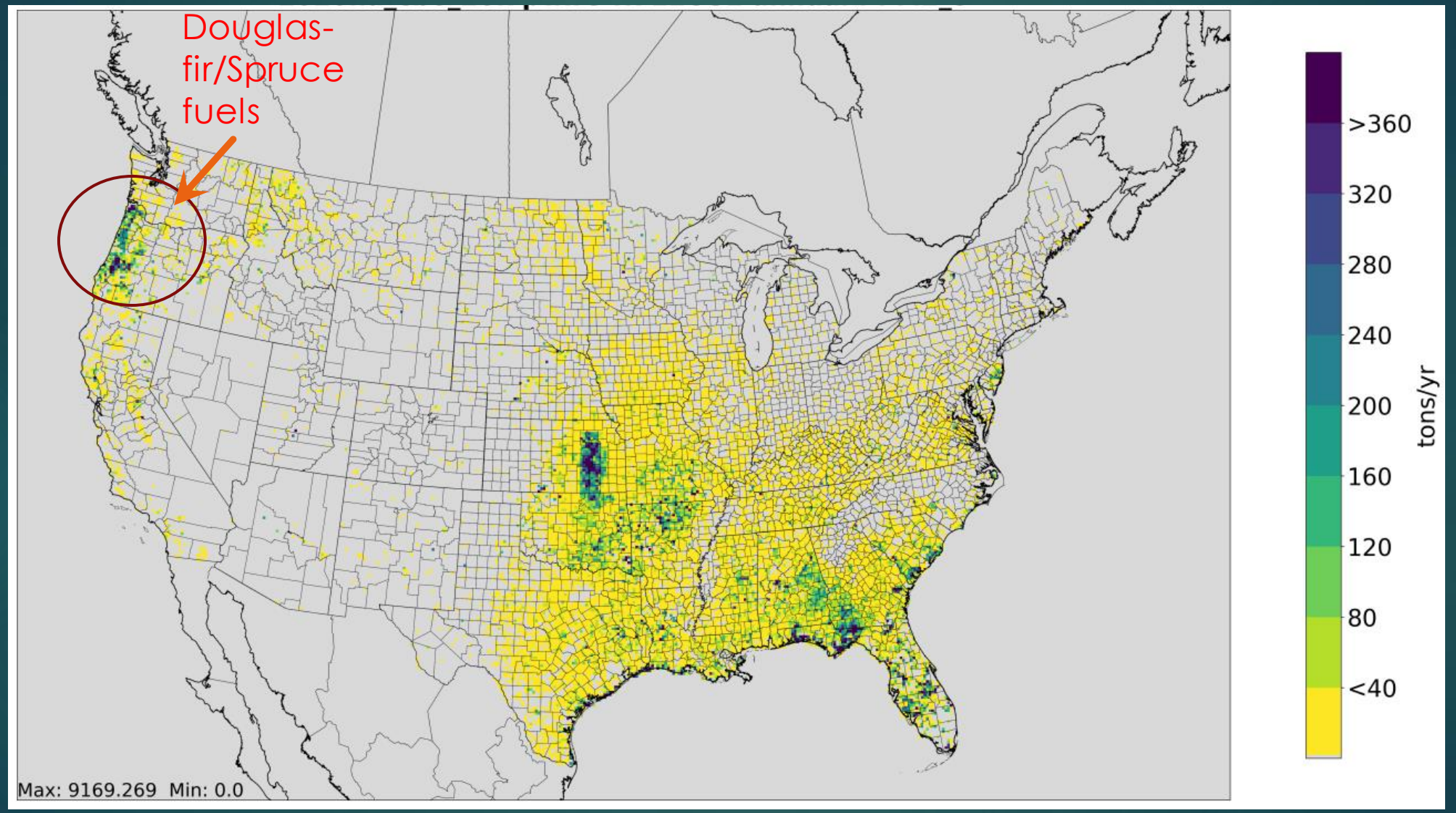
20


2020NEI Prescribed acres burned density by county
Max: 0.700504 Min: 2e-06
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
area burned/land area acres

2020NEI Annual PM2.5 Wildfires (tons/yr)



2020NEI Annual PM2.5 Prescribed burns (tons/yr)



2023NEI Plans

- Update emissions factors to SMOKE EMISSIONS REFERENCE APPLICATION (SERA) database
  - https://depts.washington.edu/nwfire/sera/index.php
- Introduce pile burn emissions estimation module(s)
- State-submitted emissions to EIS must be in nonpoint format (monthly county totals)
- Wildland Urban Interface (WUI) fires research
  - Structures and vehicles
  - Ongoing research at EPA-ORD and other agencies

Any questions about 2020NEI fires please contact

Vukovich.Jeffrey@epa.gov

THE END

BUT
EXTRA SLIDES: FYI

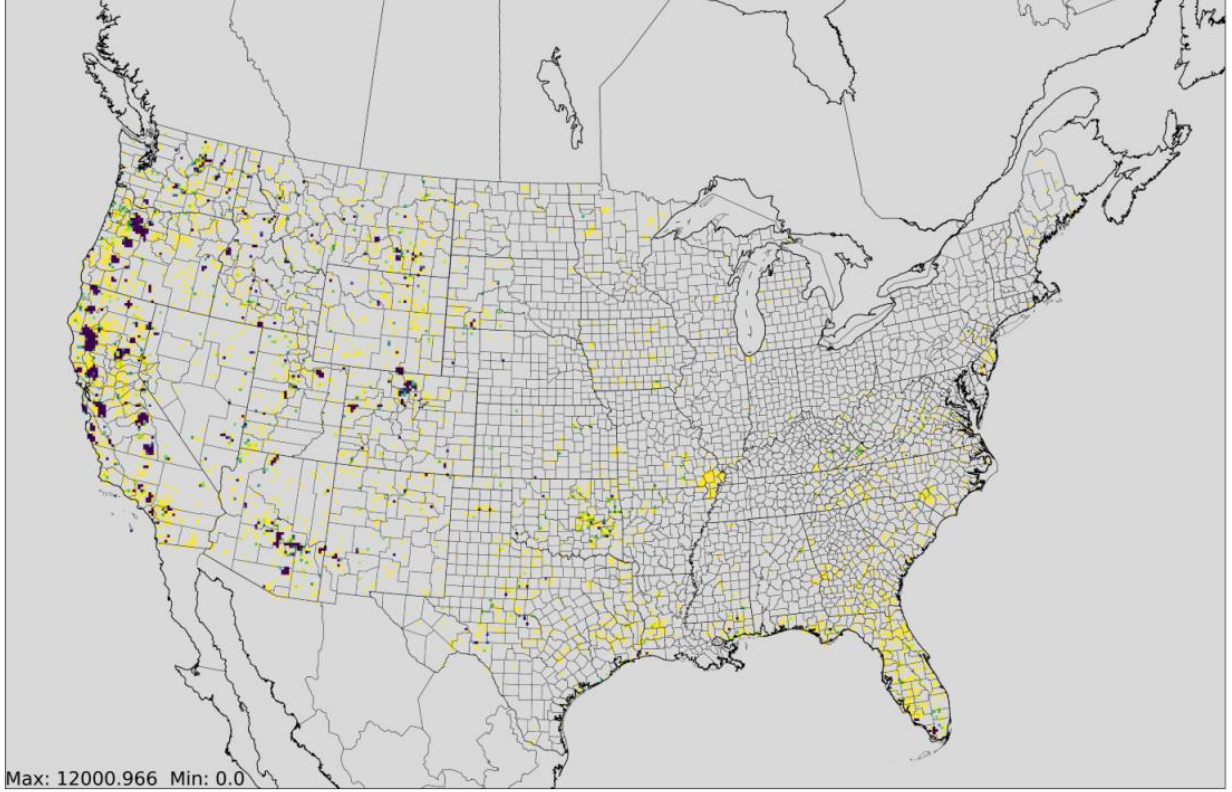
SLT DATA RECEIVED

STABBV	SLT agency	Wildfire	Prescribed burn	Agricultural burn	Notes
AK	AKDEC	Activity	Activity		
AZ	AZDEQ	Feedback	Activity	Feedback	RX data; AG feedback
CA	CARB		Activity		CARB PFIRS database used
CA	CALFIRE	Activity	Activity		Shapefiles
DE	DNREC		Activity/Feedback	Activity/Feedback	
FL	FLDEP	Activity	Activity	Activity	Didn't include WF on fedlands
GA	GADNR	Activity	Activity	Activity	GA submitting their own emissions
IA	IADNR	Feedback	Activity/Feedback	Feedback	Feedback on all types of burns
ID	IDEQ			Activity	
LA	LDAF	Activity	Activity		
MA	MADEP	Activity	Activity		
ME	ME FS	Activity			Fires on fed lands not included
MT	MTDEQ	Feedback	Activity		RX data; also QA on WFs
NC	NCDENR	Activity	Activity		QA on both types; submitted data
NJ	NJDEP	Activity	Activity		
OR	ORDEQ		Activity		
RI	RIDEM	Activity			
SC	SCDHEC	Activity	Activity	Activity	
TX	TPWD		Activity		Texas Parks and Wildlife Dept fires
UT	UTDAQ		Activity		
VA	VADEQ	Activity	Activity		
WA	WAECY	Feedback	Feedback	Feedback	Various QA/feedback on all 3 types
NV	Washoe Co AQMD	Activity	Activity		
WY	WYDEQ	Activity	Activity		
KS	KDHE		Activity		Flint Hills counties only in KS
OK	KDHE		Activity		Flint Hills counties only in OK

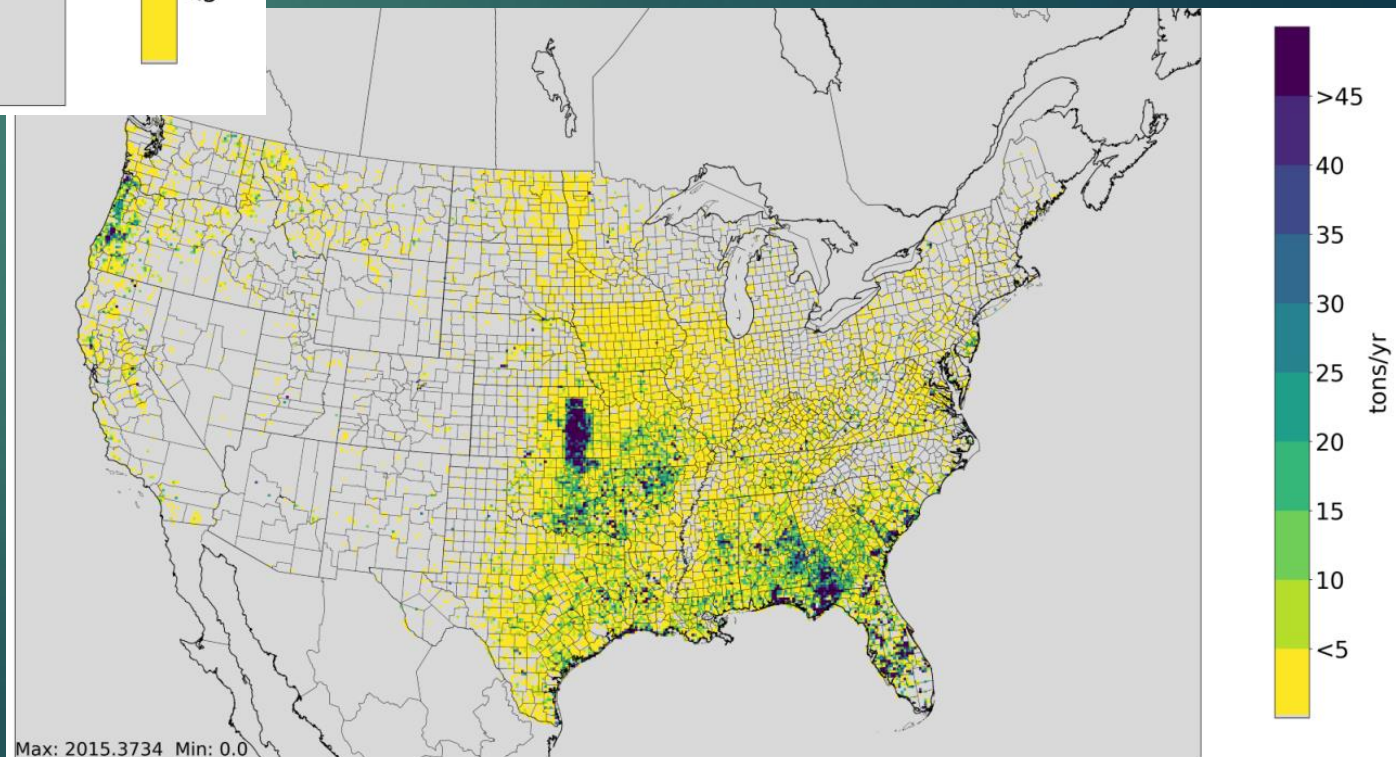
New Default acres per HMS detect (or Pixel)

Fuelbed	Original (previous NEIs)	2019 GeoMAC	2020 NIFC	2019/2020 NIFC	2020 ICS	2020 FACTS	Median w/outliers	Mean w/out outliers	Recommended (2020NEI draft)	% difference
Aspen	**80**	11	94	47	13	86	14	18	**18**	-77.5%
Boreal	**100**	22							**22**	-78.0%
Closed_Conifer_Forest	**46**	8	55	12	15	127	11	13	**12**	-73.9%
Eastern_Deciduous_Forest	**122**	36		6	42	46	36	39	**39**	-68.0%
Other	**100**	39	198	39	36	43	45	52	**39**	-61.0%
Grassland	**150**	81	36	22	46	68	62	67	**62**	-58.7%
Juniper	**80**	29	51	26	34	38	29	27	**27**	-66.3%
Open_Conifer_Forests	**70**	13	43	15	21	45	43	45	**15**	-78.6%
Pacific_broadleaved_Fores	**150**	27	22	23	29	69	38	33	**33**	-78.0%
Riparian	**75**	58			48	303	86	57	**57**	-24.0%
Savanna	**100**	72	51	55	44		59	65	**59**	-41.0%
Shrubland	**200**	77	21	21	32	221	46	41	**41**	-79.5%

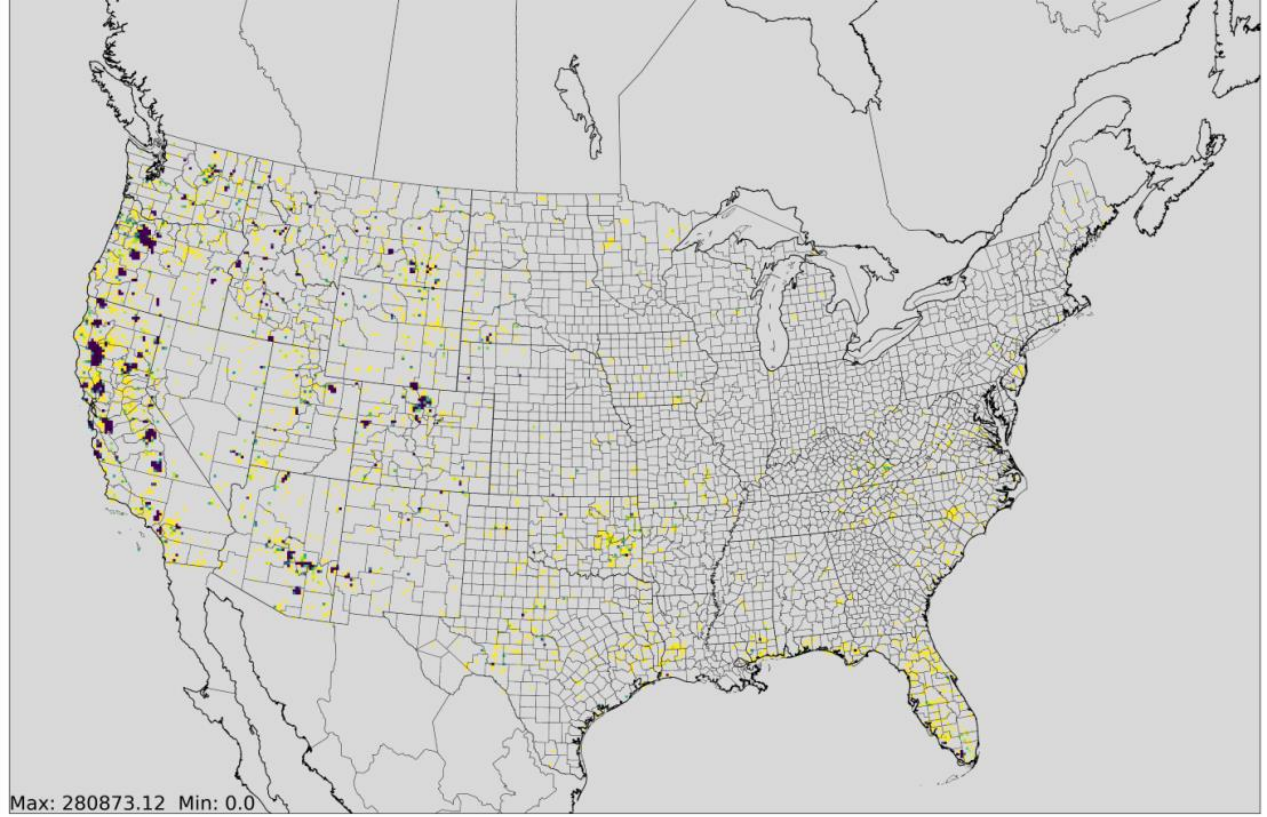
Annual NOX
Prescribed fires



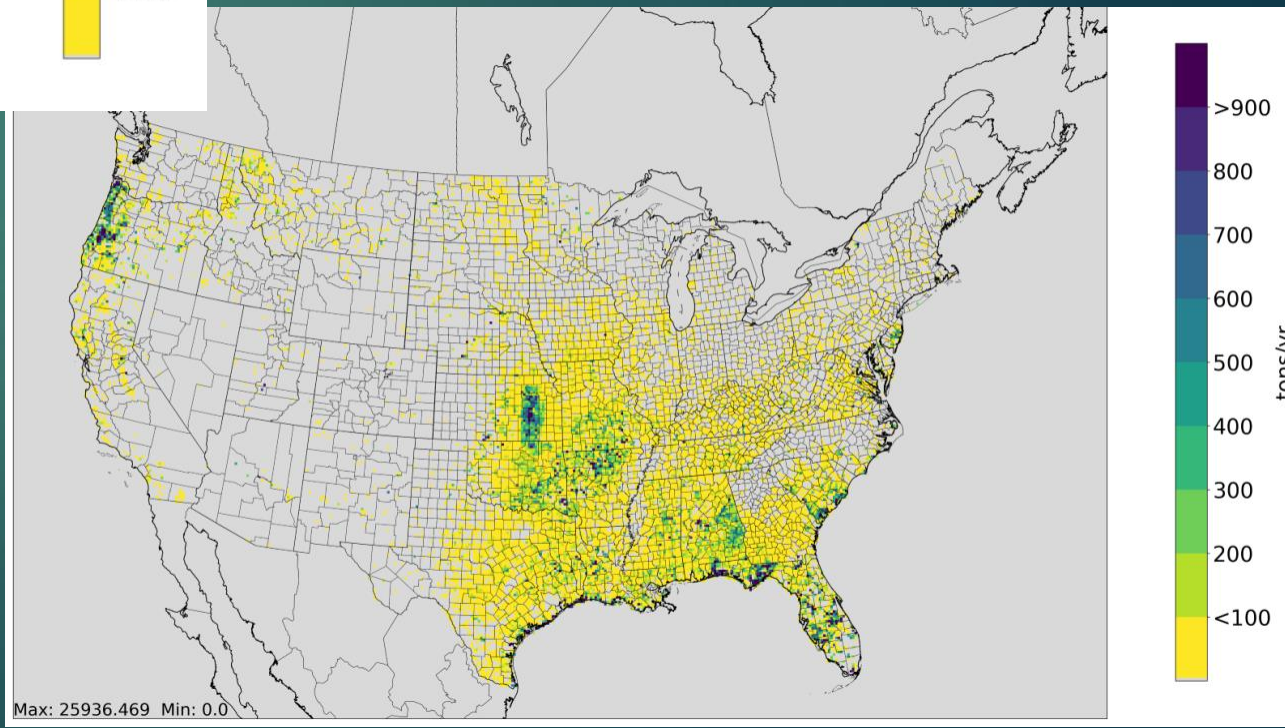
Annual NOX
Wildfires



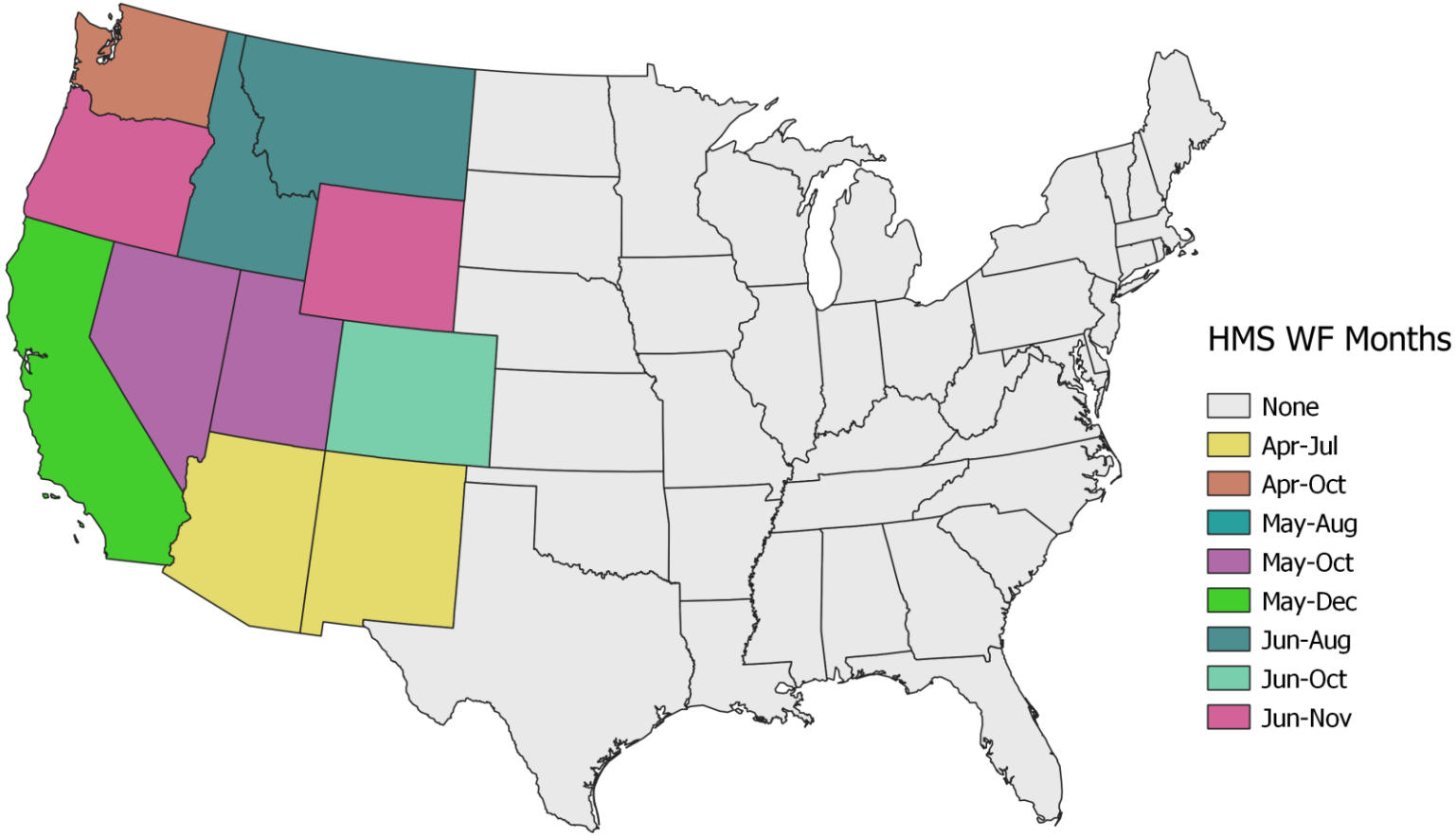
Annual VOC Prescribed fires



Annual VOC Wildfires



2020 NEI Draft HMS Default Wildfire Type Months



Crop Reside Burns 2020 NEI

- Updated approach to identify crop residue burns:
- Categorize detects based on grasses, Flint Hills spring burning seasons, sugar cane, rice/wheat, everything else
  - Grasses are processed in SF2 as a separate stream (rx and wf)
  - Flint Hills (see Flint Hills Slide)
- Sugarcane: use area harvested from USDA or LSU (Louisiana); use HMS detects to estimate acres/detect by state; use emission factors (from SPECIATE for PM2.5/VOC) to estimate emissions Texas: 114 acres/detect (25% green harvested); LA 28 acres/detect (62.5 % green harvested; FL 60 acres/detect)
- Rice/Wheat: use state specific field sizes per detect; Use emission factors as in 2014/2017 NEI to calculate emissions: *Pouliot G, Rao V, McCarty JL, Soja A. Development of the crop residue and rangeland burning in the 2014 National Emissions Inventory using information from multiple sources. Journal of the Air & Waste Management Association. 2017 Apr 27;67(5):613-22.*
- 2020 Draft: 5.86M acres burned and about 68K tons of PM2.5 emitted

Default acres per HMS detect update to account for new satellites product suites

- High-level overview
  - Remove any duplicate detects (to thousandths place on same day)
  - Find intersections of the following:
    - HMS detect
    - Fire activity shapefiles (e.g. GeoMAC 2019, NIFS 2020, FACTS 2019 and 2020)
    - SmartFire2 fuel-bed shapes (12 different veg types)
  - Compute acres per veg type and total detects per veg type
  - Divide the acres per veg type by the total detects per veg type to get an overall acres/pixel
  - Compare statistics, using median values and outlier tests to get reasonable acres/pixel value by type