EPA's National Emissions Inventory for Wildland Fires

GREENHOUSE GAS EMISSIONS FROM WILDLAND FIRES WORKSHOP SEPT 13-15, 2023

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

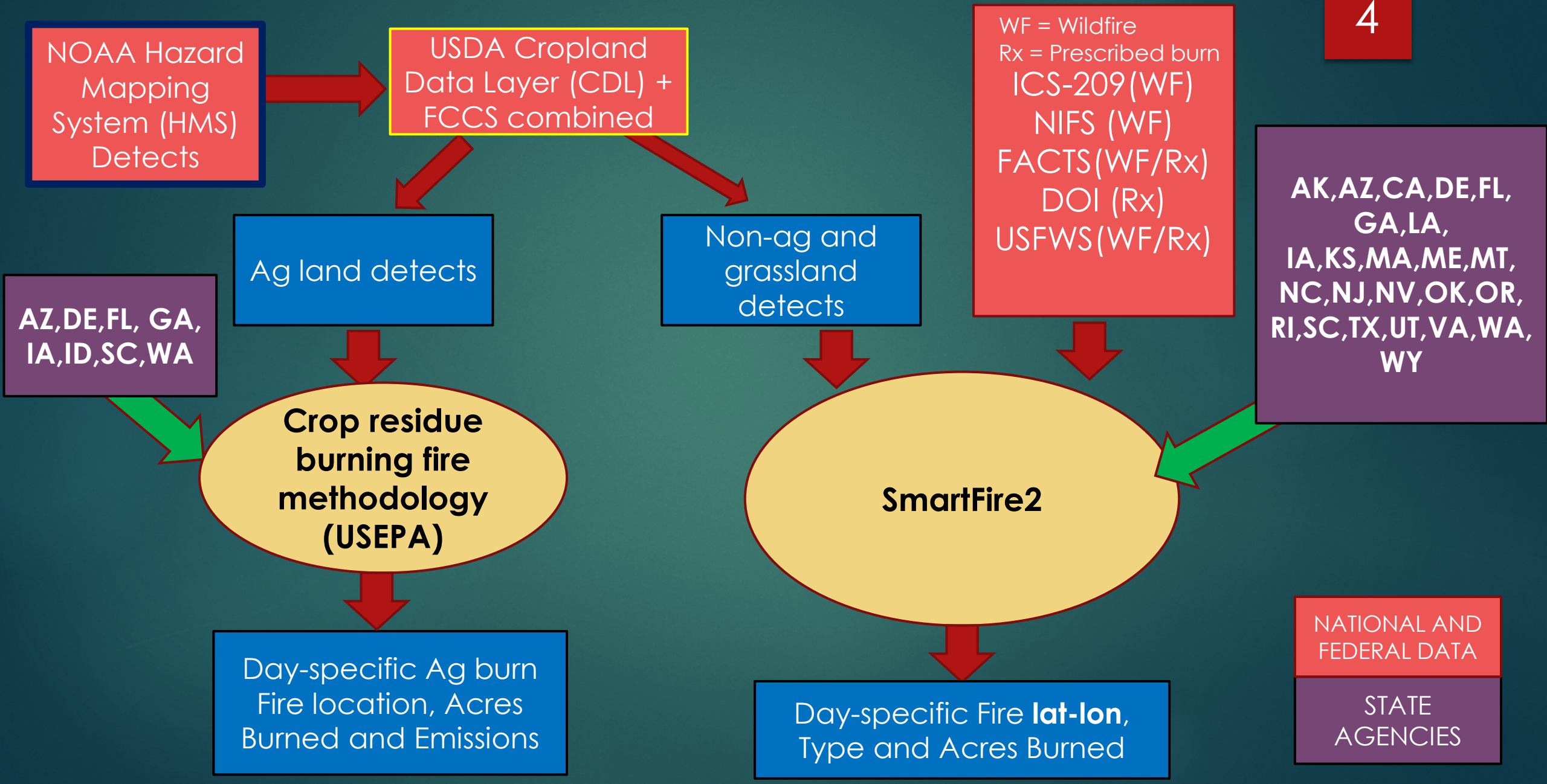
NEI: Fire inventory summary

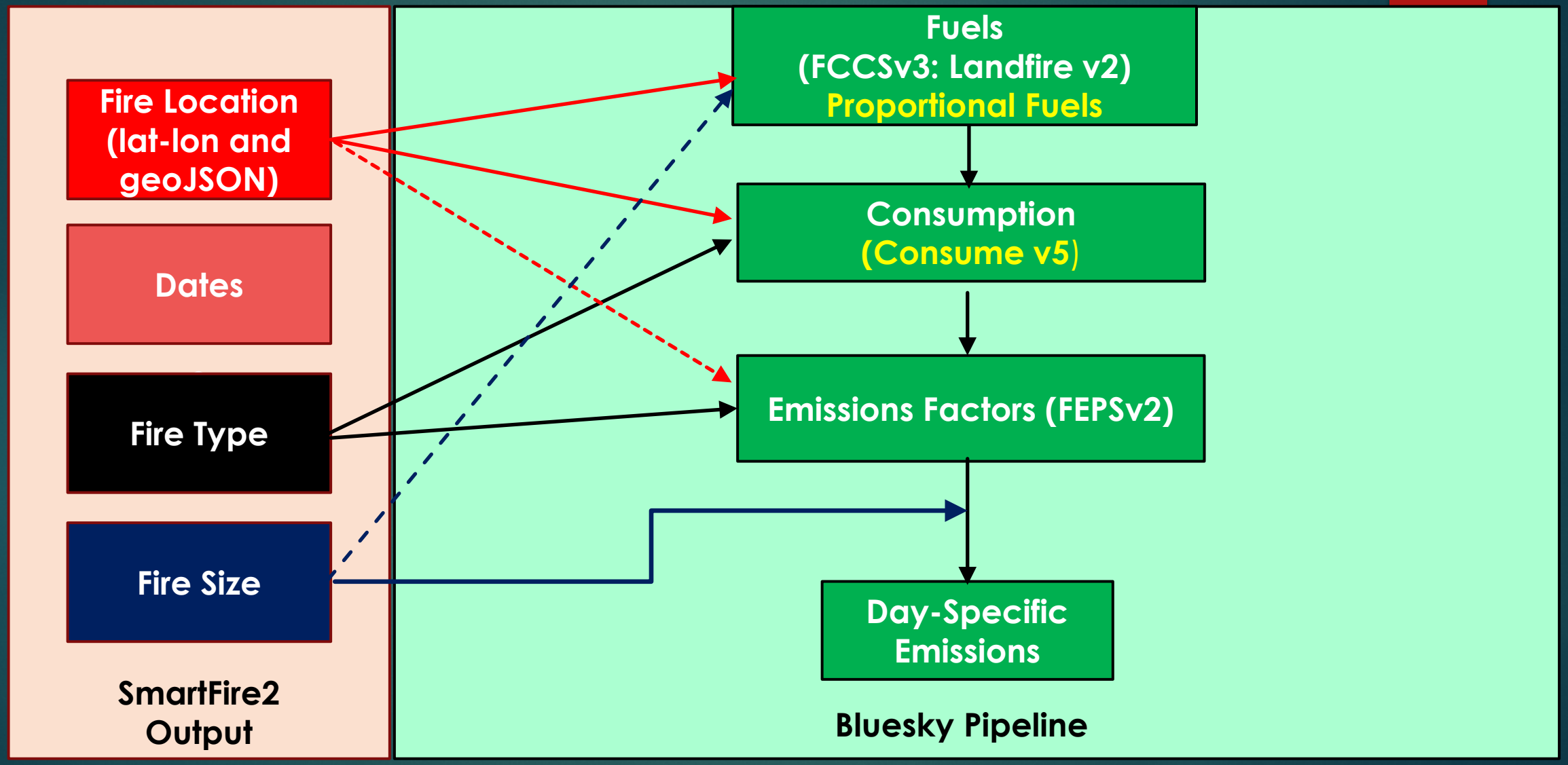
- National Emissions inventory (NEI) is developed by USEPA **every 3 years** for anthropogenic, fires and biogenic (vegetation) sources
- Produce **day-specific** emissions for prescribed burns and wildfires
- Emissions include Criteria Air Pollutants (CAPs) and Hazard Air Pollutants (HAPs)
  - GHGs: CO2 and CH4 included
- 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 USFS's Bluesky Pipeline to estimate emissions
- Emissions are provided for both flaming and smoldering phases

Non-NEI year fire inventory work and Fire inventory uses

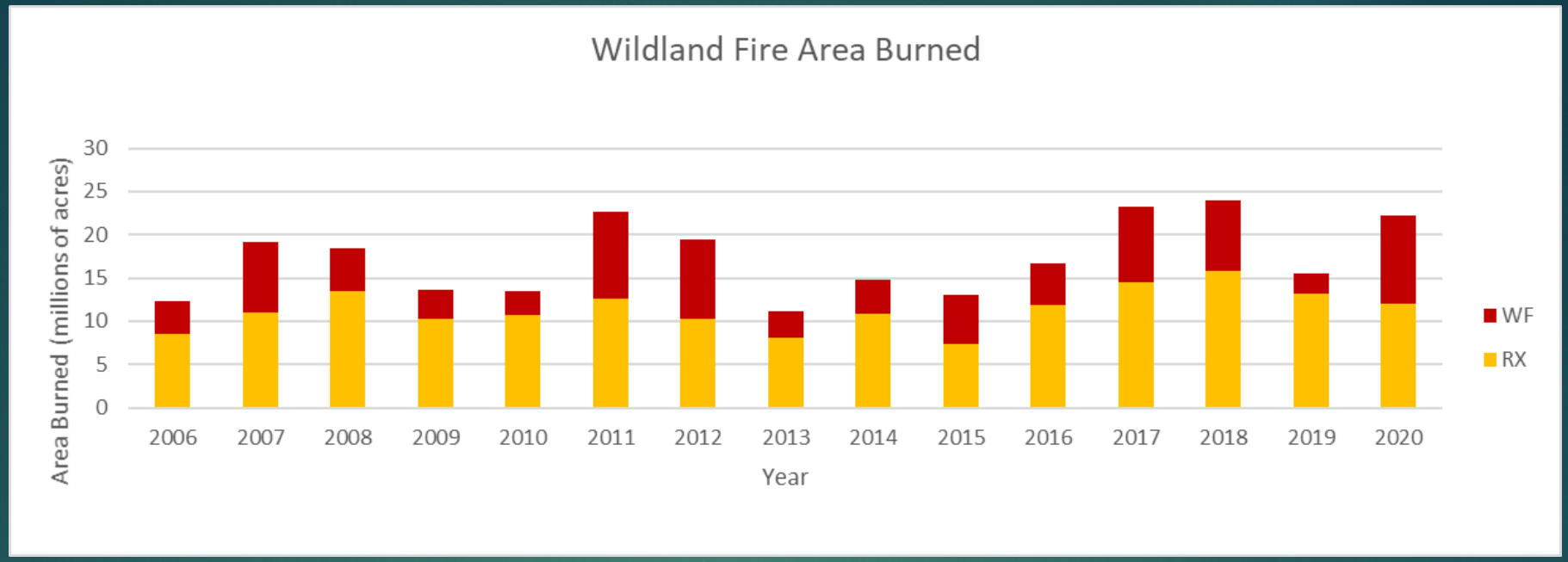
- EPA generates fire inventories for other years besides NEI years
  - Generated in very similar manner but usually with far less activity databases (e.g. limited prescribed fire activity data from state agencies is used)
  - Exceptions to this are for years 2016 and upcoming year 2022 work where EPA collaborates with regional, state and other federal agencies to generate a fire inventory very similar to an NEI effort
- The NEI Fire inventory data are typically used:
  - Emissions trends reporting
  - Regulatory air quality and risk assessment modeling
  - Research air quality modeling
- Other EPA GHG inventory (national, annual resolution only) produced by Office of Atmospheric Protection:
  - https://www.epa.gov/system/files/documents/2023-02/US-GHG-Inventory-2023-Main-Text.pdf

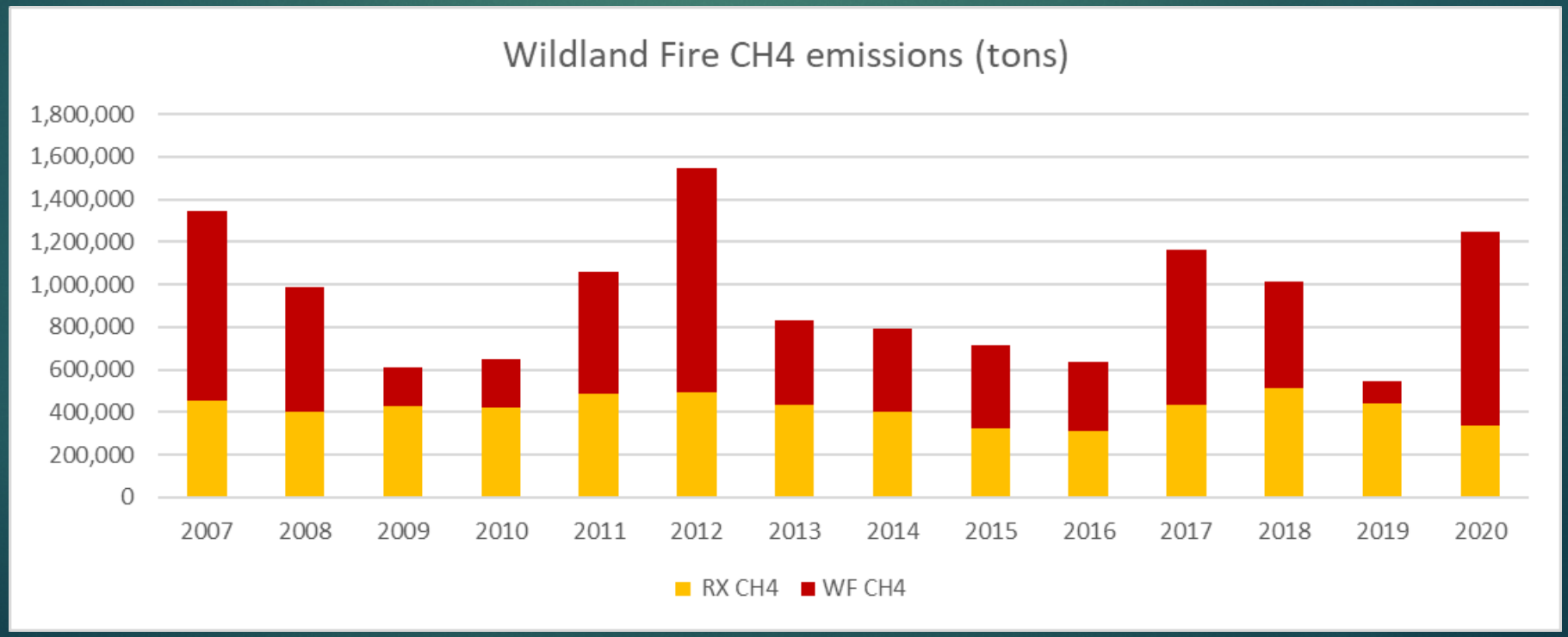
Smartfire2 and Agriculture burn processing for 2020 NEI



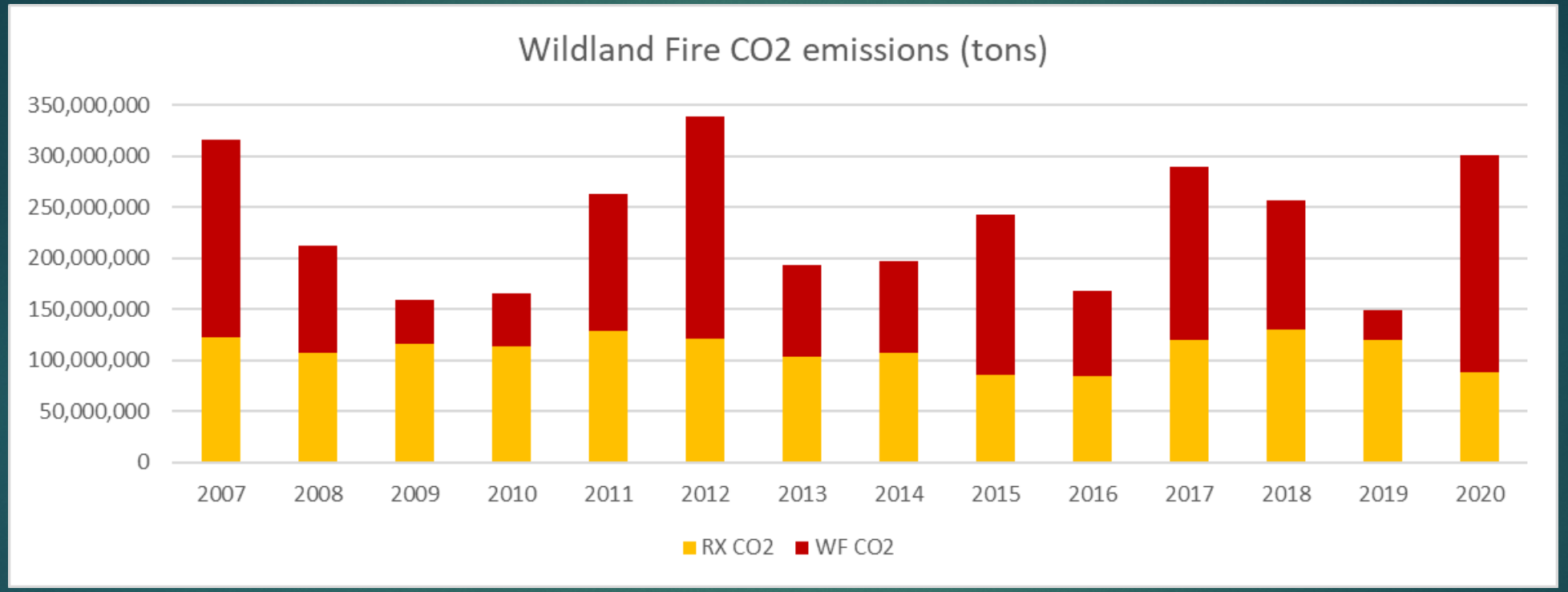


FCCS = Fuel Characteristic Classification System FEPS = Fire Emission Production Simulator



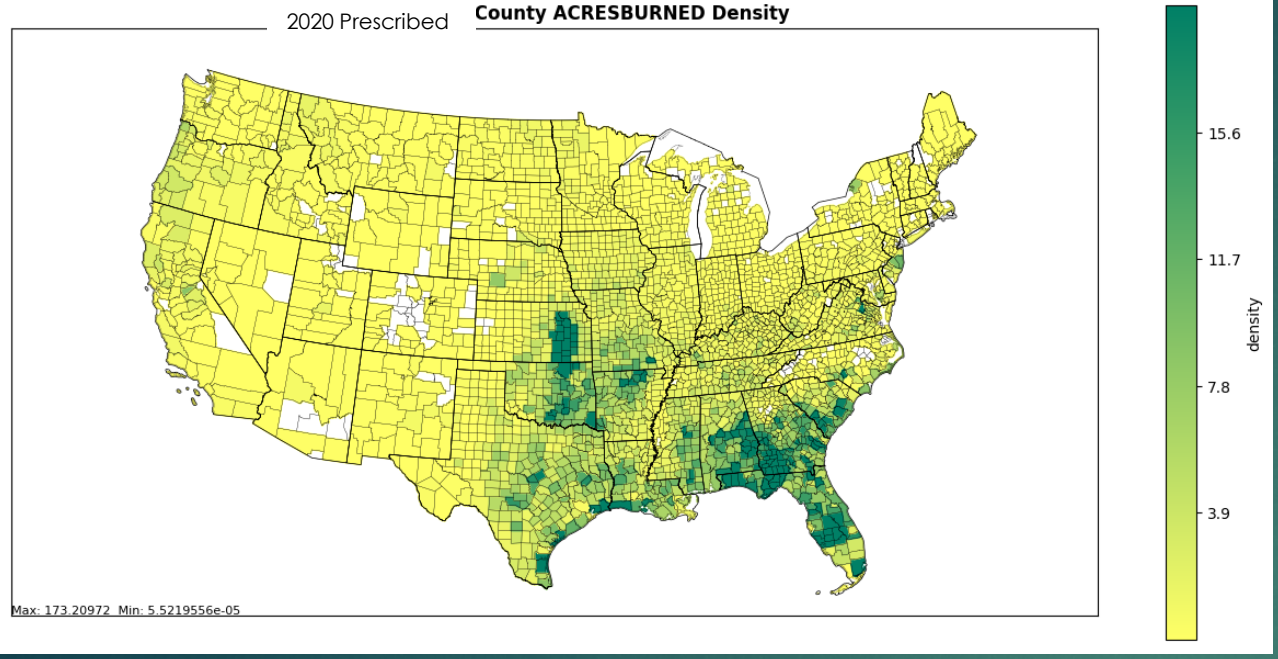


Emissions factor from FEPS and included in NEI

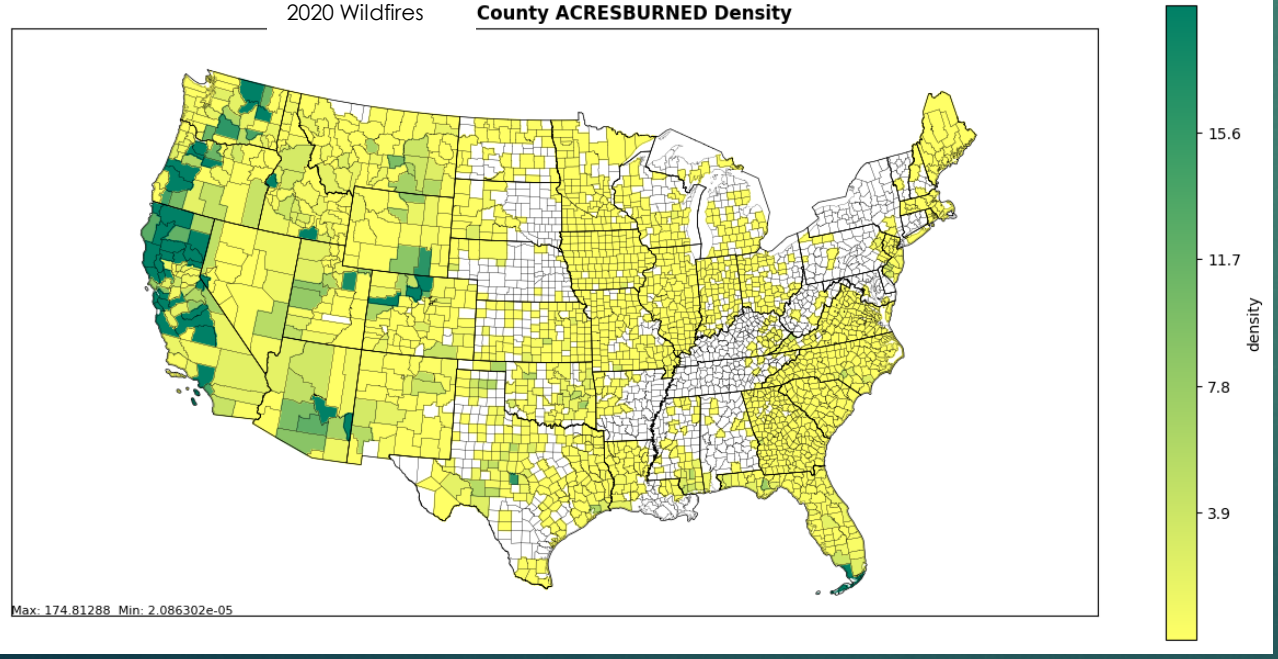


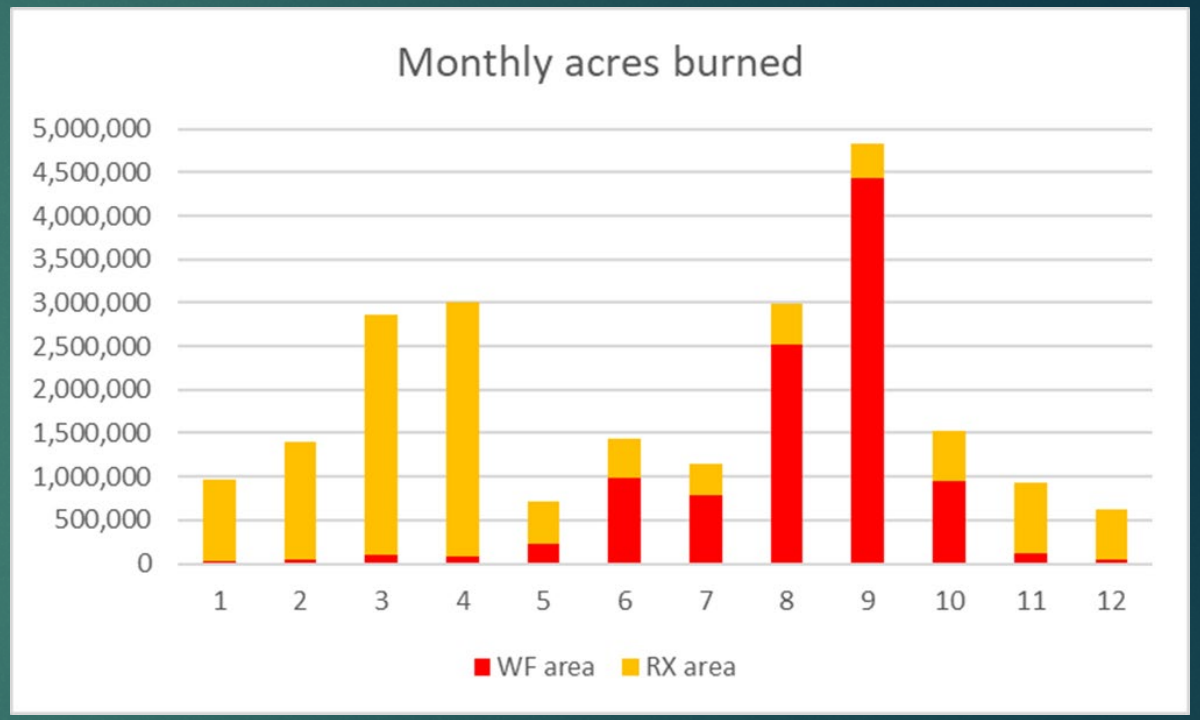
Emissions factor from FEPS and included in NEI

2020 Prescribed



2020 Wildfires





Largest gaps, uncertainties, possible improvements and challenges

- Assumptions when only satellite detect available
  - Large areas of CONUS without prescribed fire activity on-the-ground data but 10,000s of detects; left with assumptions based on historical burns
  - Better quality control of satellite detects assumed to be fire by HMS (solar farms, snow cover)
- Use of other satellite data to possibly improve emissions estimates (e.g. Fire Radiative Power (FRP))
- Consumption
  - We assume climatological values for fuel moisture in CONSUME model
  - Duff assumptions

Largest gaps, uncertainties, possible improvements and challenges: continued

- Vertical Distribution
  - Better tools to evaluate heat fluxes from fires and the resulting plume rise (plume injection height) and its impact on air quality modeling
- Broadcast vs pile burns
  - Separate method(s) needed for pile burns
- Emissions Factors
  - More published emissions factors for GHGs, CAPs, and HAPs
    - Smoke Emissions Reference Application(SERA) will be used moving forward
  - Confidence high with CO2 and methane emissions factors
  - Want to add emissions factors for nitrous oxide, carbon tetrachloride, methyl chloride, others and add to NEI

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%**

2020 NEI example

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%

Any questions about 2020NEI fires please contact

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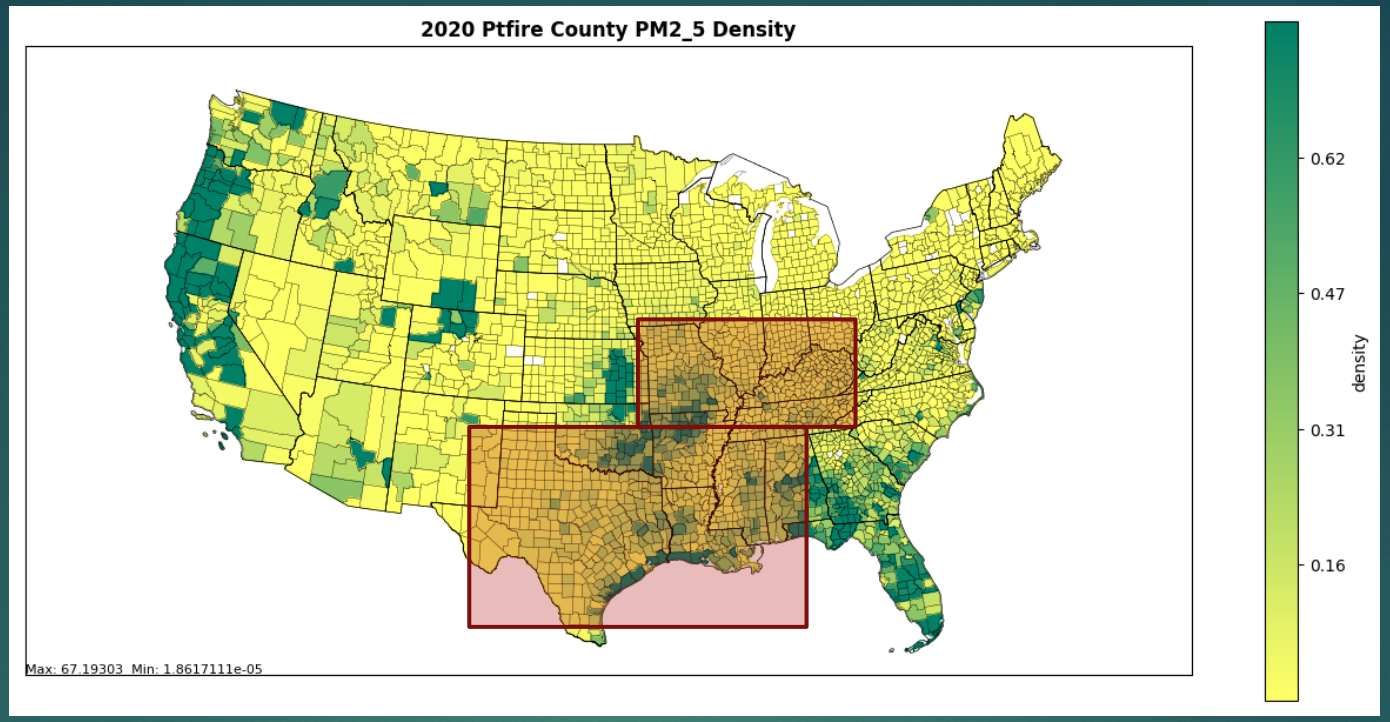
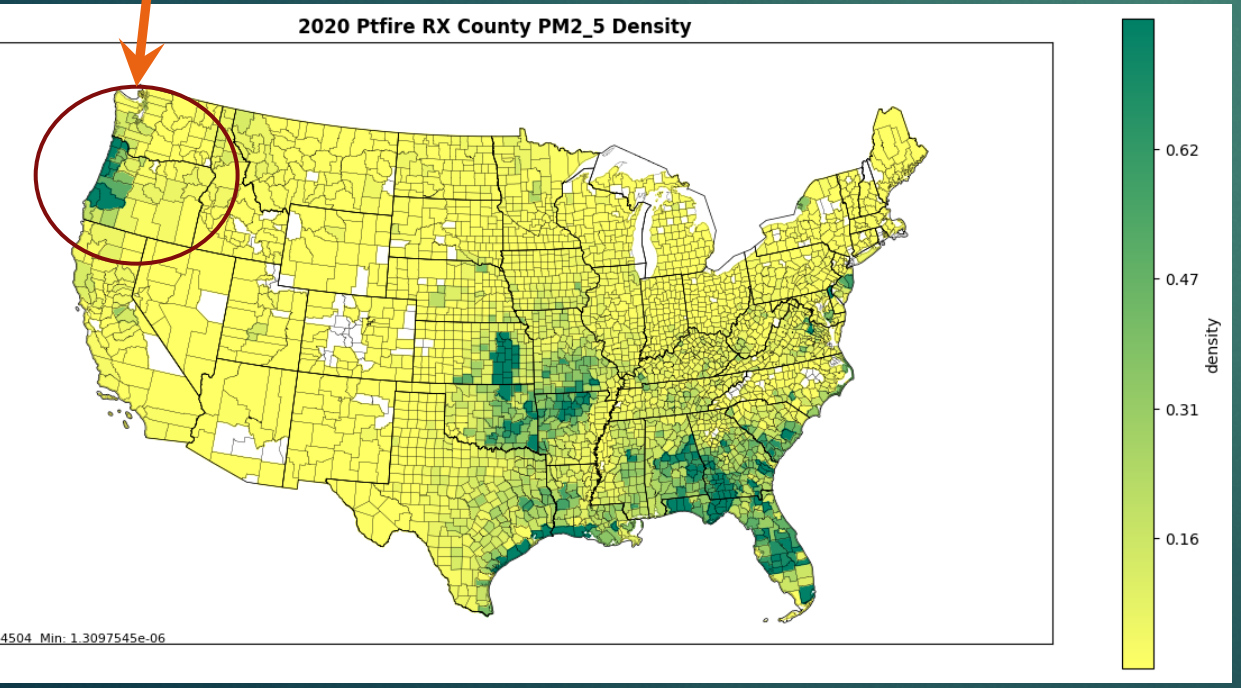
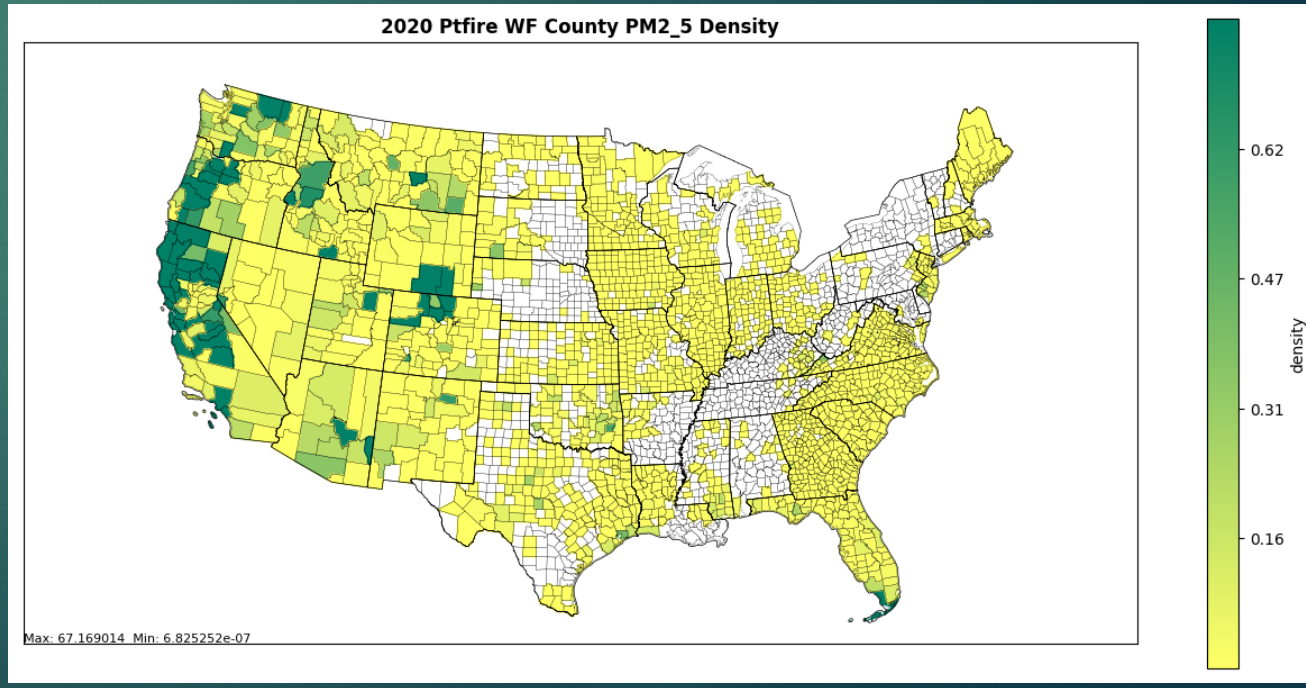
THE END

BUT
EXTRA SLIDES: FYI

Douglas-fir/Spruce fuels



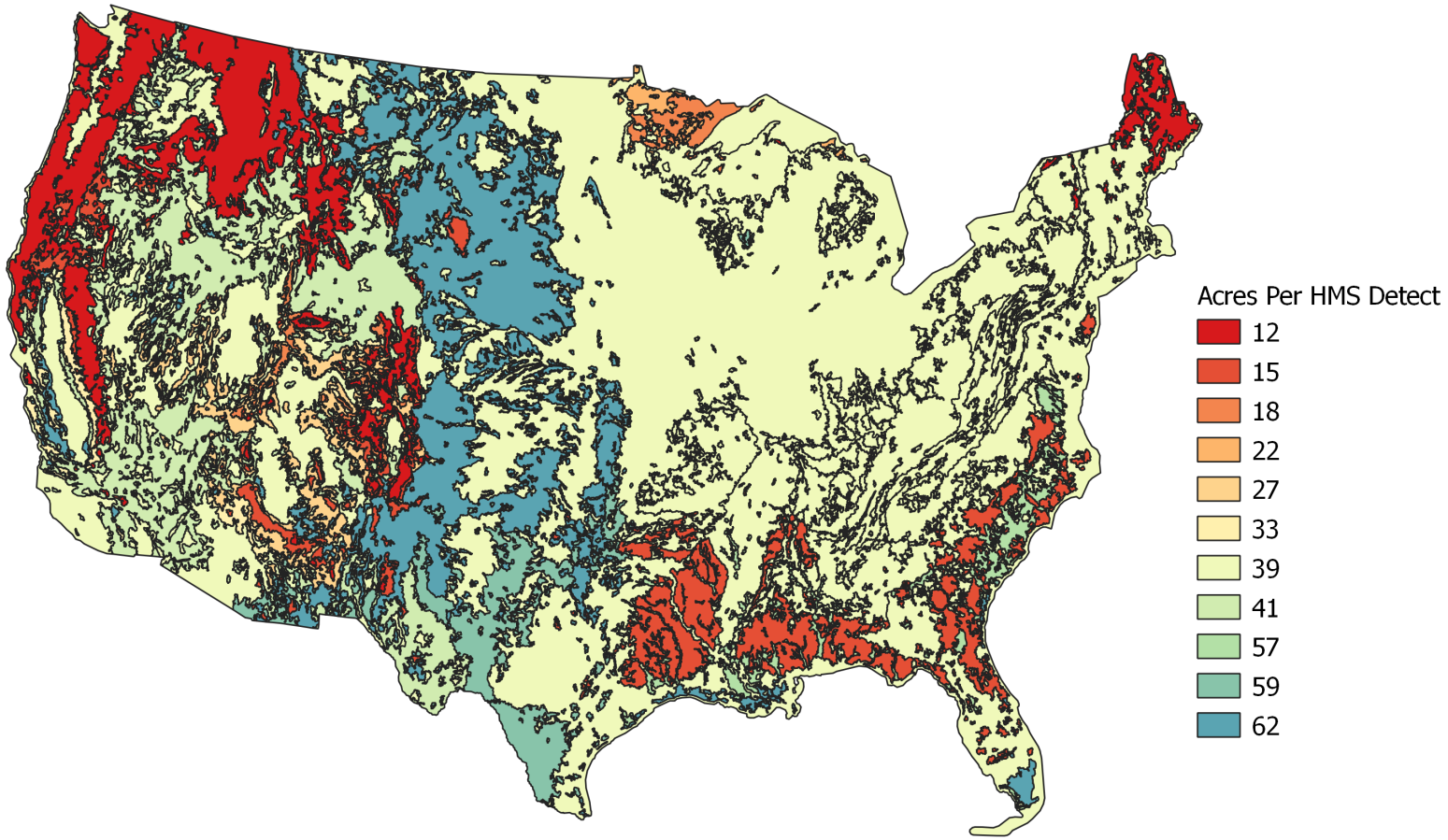




New Default acres per HMS detect (or Pixel)

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%

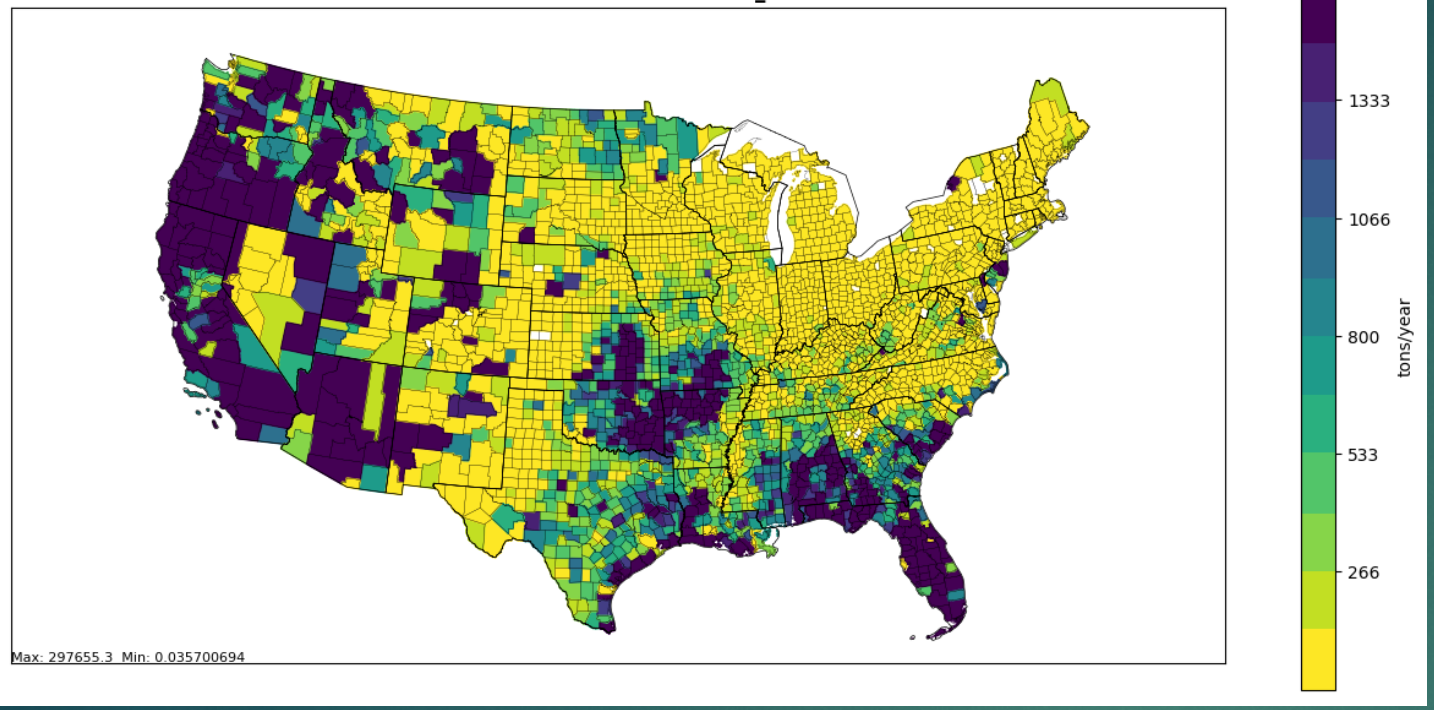
2020 NEI Acres Per HMS Detect



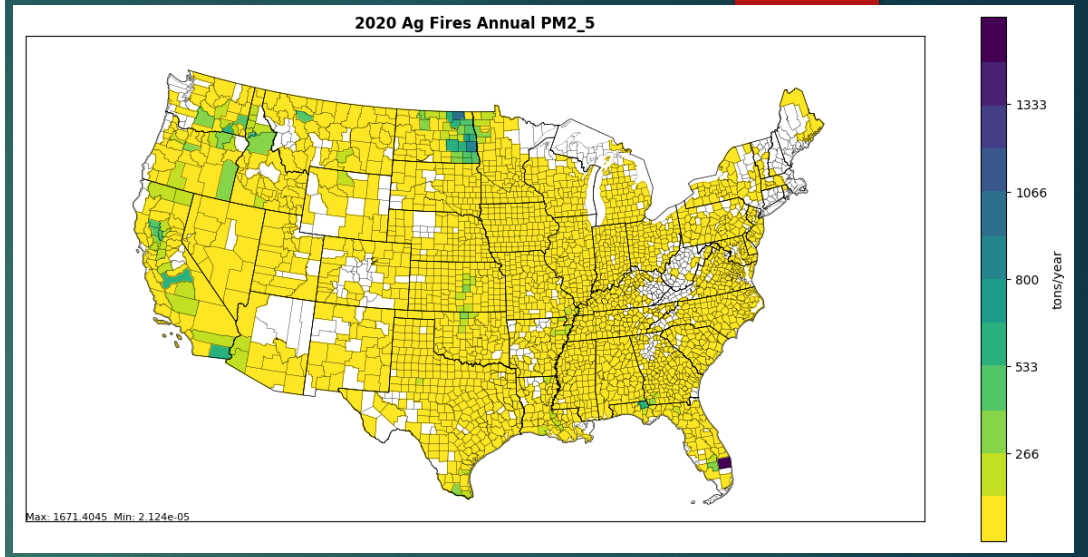
Assumed acres burned

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

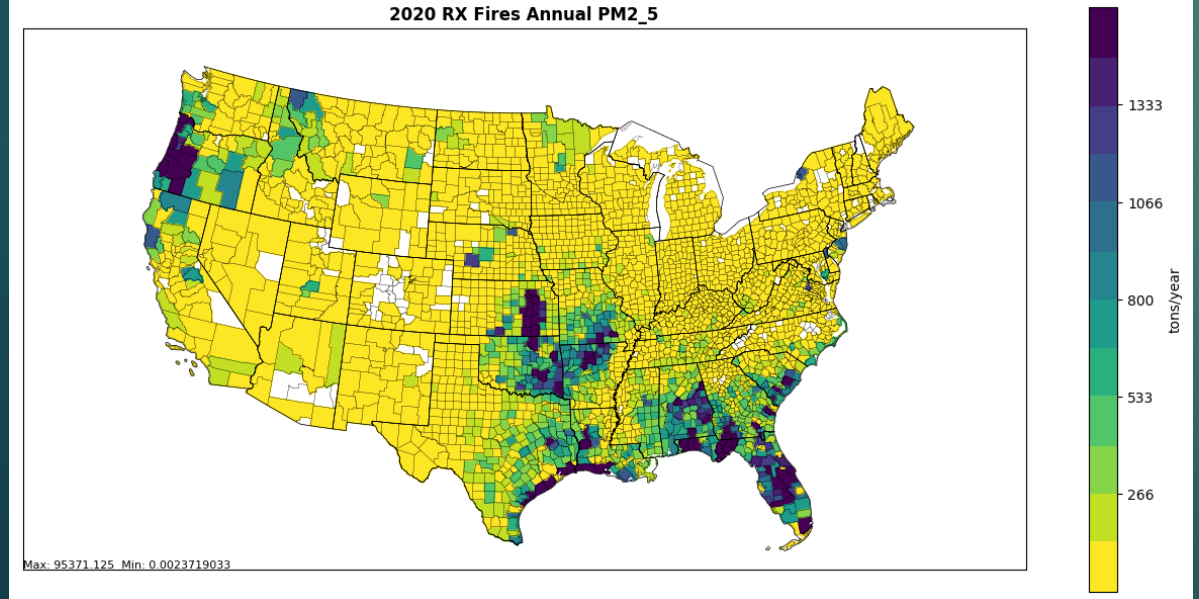
2020 All Fires Annual PM2_5



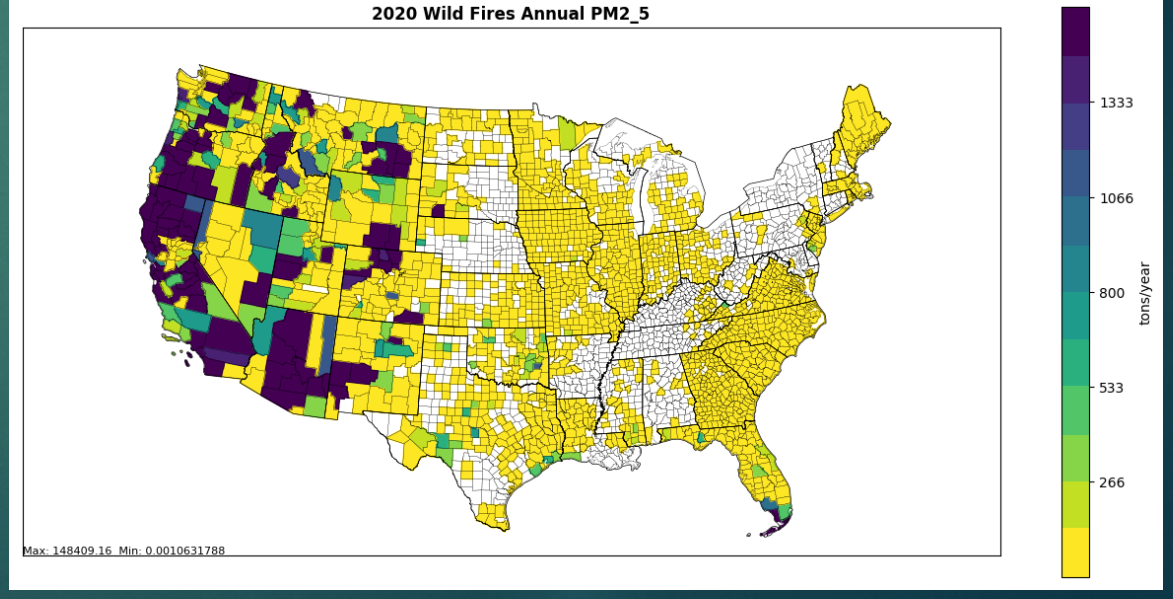
2020 Ag Fires Annual PM2_5



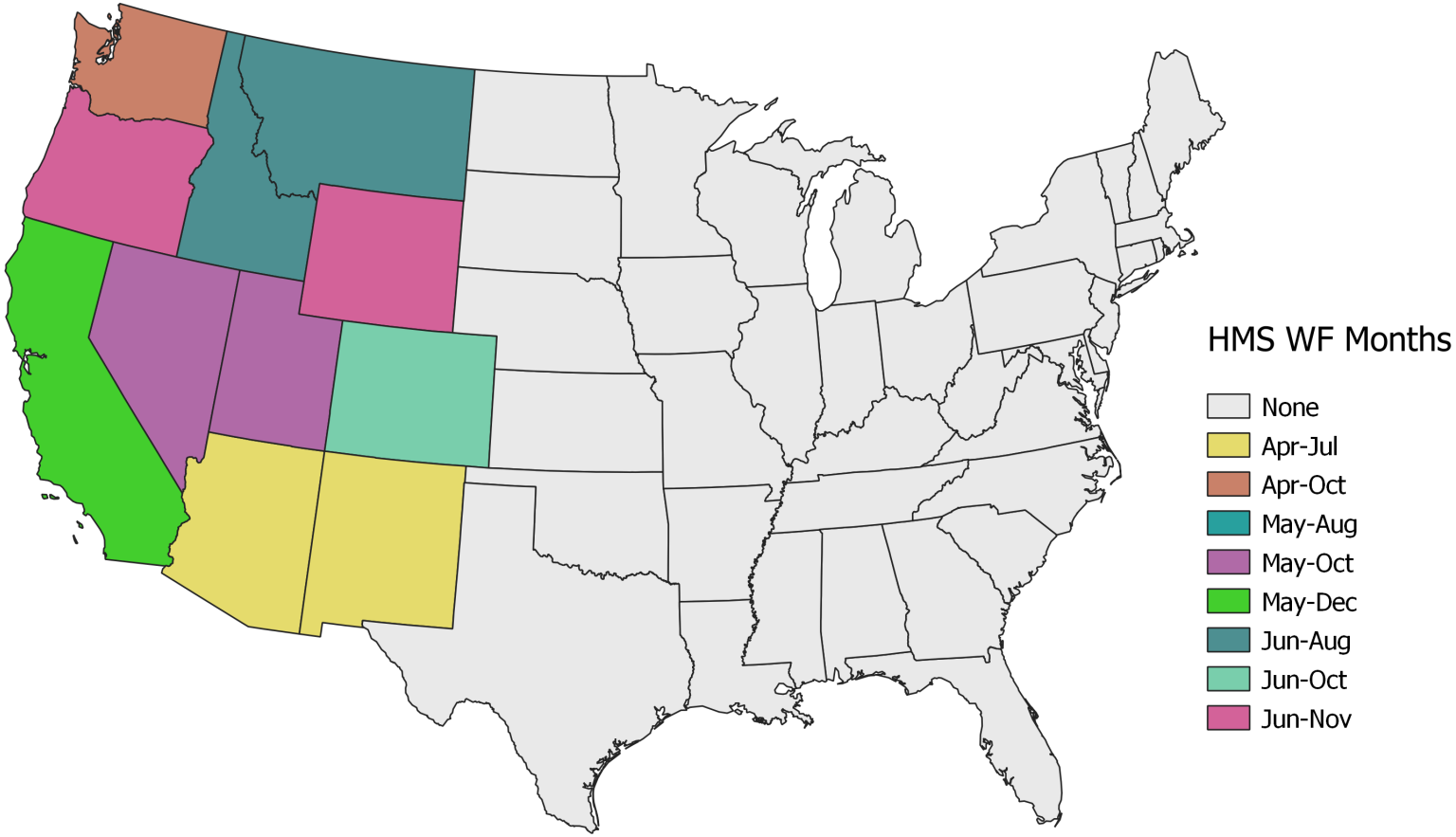
2020 RX Fires Annual PM2_5



2020 Wild Fires Annual PM2_5



2020 NEI HMS Default Wildfire Type Months



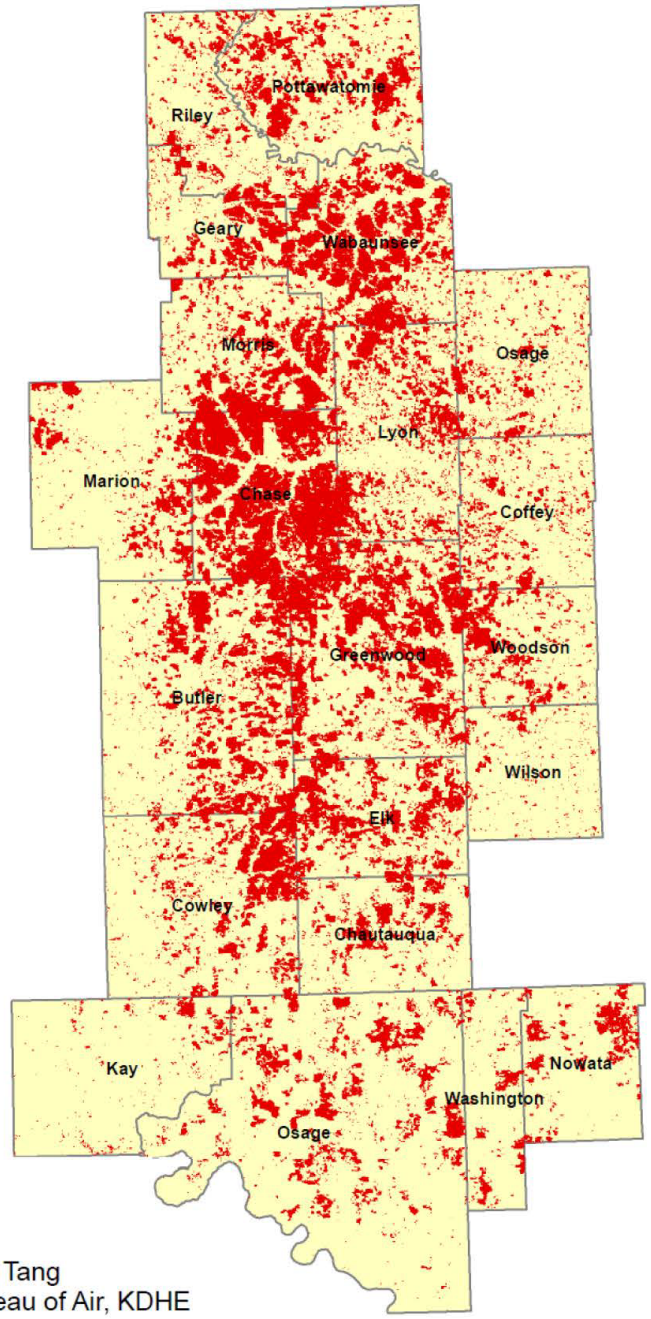
Bluesky Pipeline (BSP)

- USFS has significantly updated the Bluesky Framework and named the new system "Bluesky Pipeline"
- It is open source at https://github.com/pnwairfire/bluesky

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
- PM2.5 from measurements in Flint Hills Amara Holder: 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

2020 NEI 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

Prescribed burn emissions: Top State totals

stid	st_name	type	area	pm25	voc	nox	co
20	Kansas	RX	2,653,259	64,440	124,264	16,617	418,824
48	Texas	RX	1,530,896	83,124	223,468	15,129	944,526
12	Florida	RX	1,386,808	95,716	251,227	20,413	1,057,756
13	Georgia	RX	1,141,531	65,202	168,728	15,088	708,746
40	Oklahoma	RX	1,039,072	48,794	121,675	11,292	499,243
1	Alabama	RX	673,865	44,846	116,108	10,350	487,754
5	Arkansas	RX	410,213	41,133	110,173	7,687	465,388
29	Missouri	RX	405,937	35,979	95,930	6,495	403,223
22	Louisiana	RX	389,916	32,105	85,846	6,071	362,528
28	Mississippi	RX	334,932	19,729	50,937	4,623	213,879
45	South Caroli	RX	314,497	19,183	50,515	4,010	212,801
19	Iowa	RX	164,596	7,403	18,356	1,495	74,202
41	Oregon	RX	162,152	46,119	130,524	5,181	556,079

National Emissions Totals

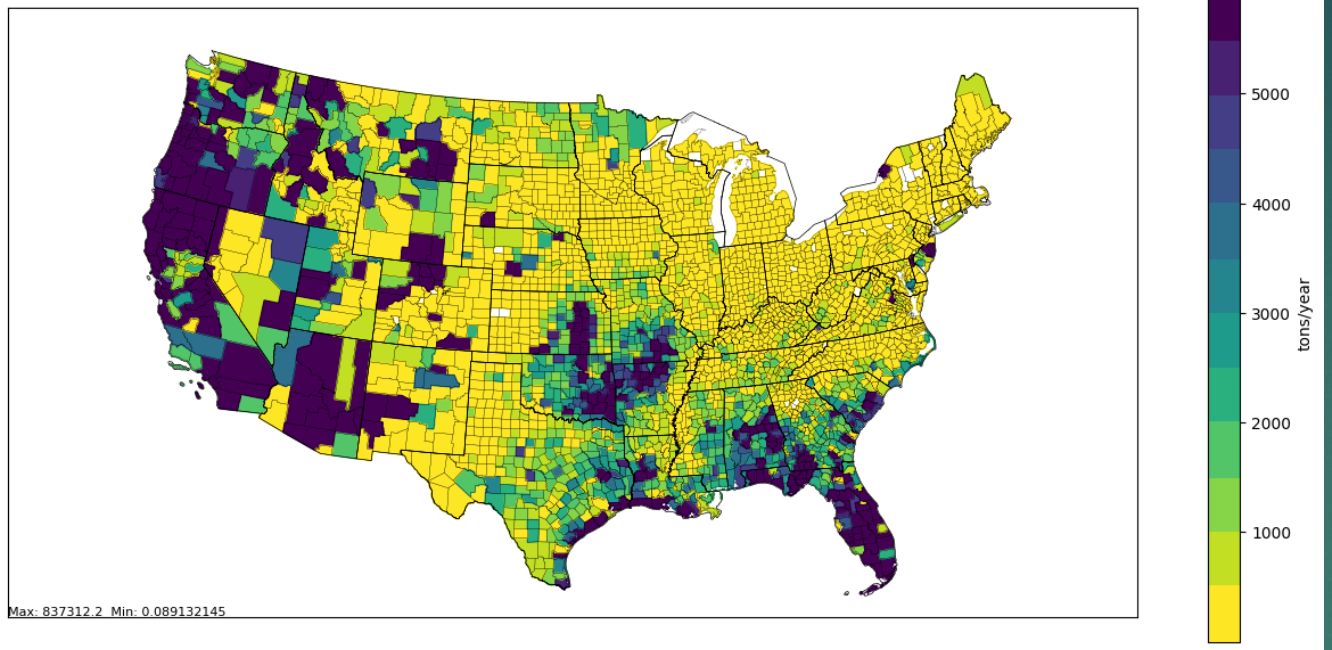
	pm25	nox	voc	DRAFT pm25	DRAFT nox	DRAFT voc	% pm25 chg	% nox chg	% voc chg
RX	797,604	150,409	2,086,056	768,758	148,502	2,006,537	3.75%	1.28%	3.96%
WF	1,685,697	248,028	4,650,974	1,724,564	251,312	4,763,615	-2.25%	-1.31%	-2.36%
TOTAL	**2,483,301**	**398,438**	**6,737,030**	**2,493,322**	**399,813**	**6,770,152**	**-0.40%**	**-0.34%**	**-0.49%**

	pm25	nox	voc
WF smoldering	439,164	23,976	1,294,540
WF flaming	1,246,533	224,053	3,356,433
RX smoldering	122,426	6,684	360,881
RX flaming	675,177	143,726	1,725,175
TOTAL	**2,483,301**	**398,438**	**6,737,030**

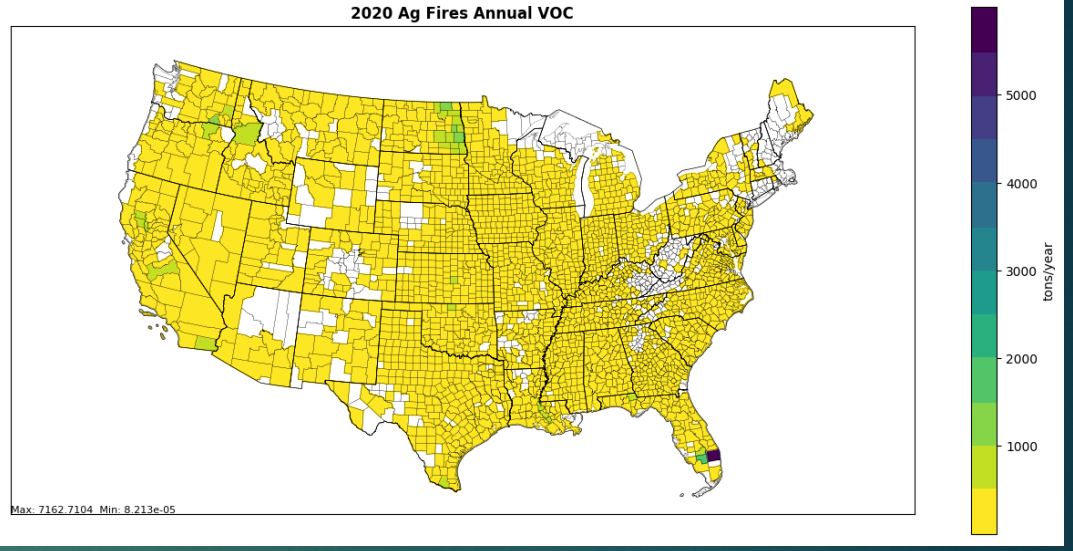
Wildfire emissions: Top State totals

stid	st_name	type	area	pm25	voc	nox	co
6	California	WF	4,124,077	562,456	1,521,566	97,711	6,437,519
41	Oregon	WF	1,101,771	569,847	1,600,448	70,069	6,810,602
4	Arizona	WF	990,864	48,642	128,392	10,019	541,073
53	Washington	WF	877,051	54,864	148,176	9,651	626,745
8	Colorado	WF	707,261	155,091	434,929	19,390	1,850,393
30	Montana	WF	342,310	27,367	74,189	4,678	313,984
16	Idaho	WF	337,629	58,525	163,076	7,832	693,126
56	Wyoming	WF	323,747	35,860	98,689	5,404	418,662
49	Utah	WF	310,404	41,266	115,602	5,219	491,744
32	Nevada	WF	254,927	6,524	16,890	1,506	70,954
48	Texas	WF	209,545	7,332	19,219	1,577	80,902
2	Alaska	WF	178,948	76,696	221,410	6,481	946,059

2020 All Fires Annual VOC



2020 Ag Fires Annual VOC



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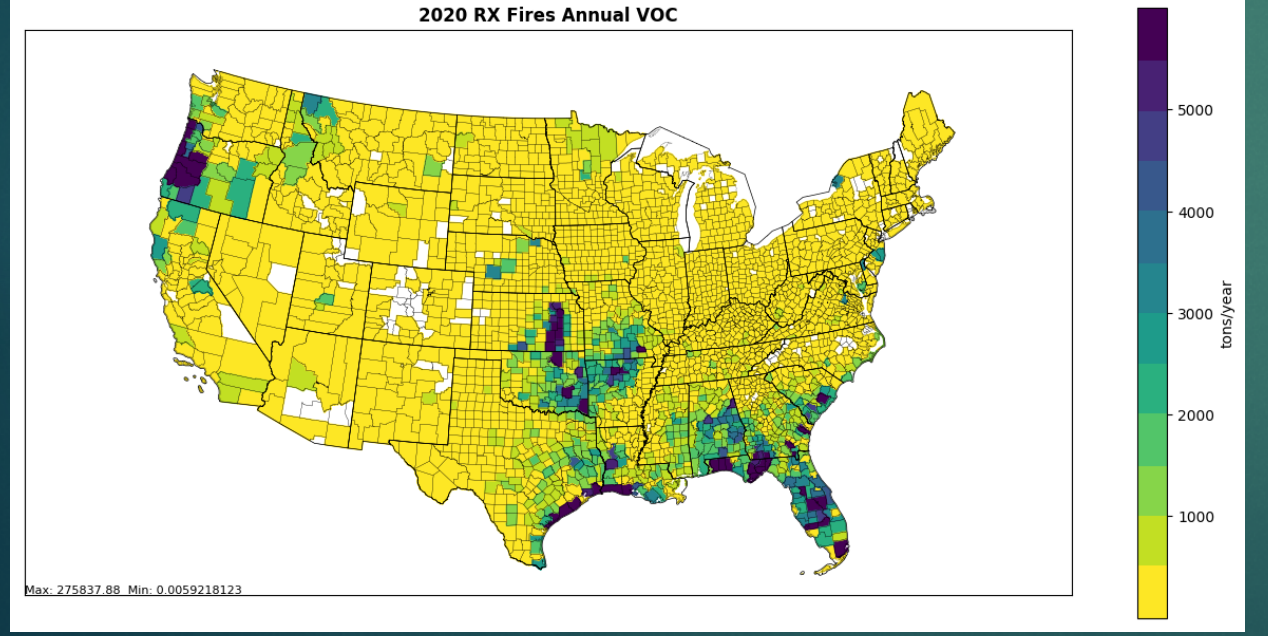

2020 Wild Fires Annual VOC