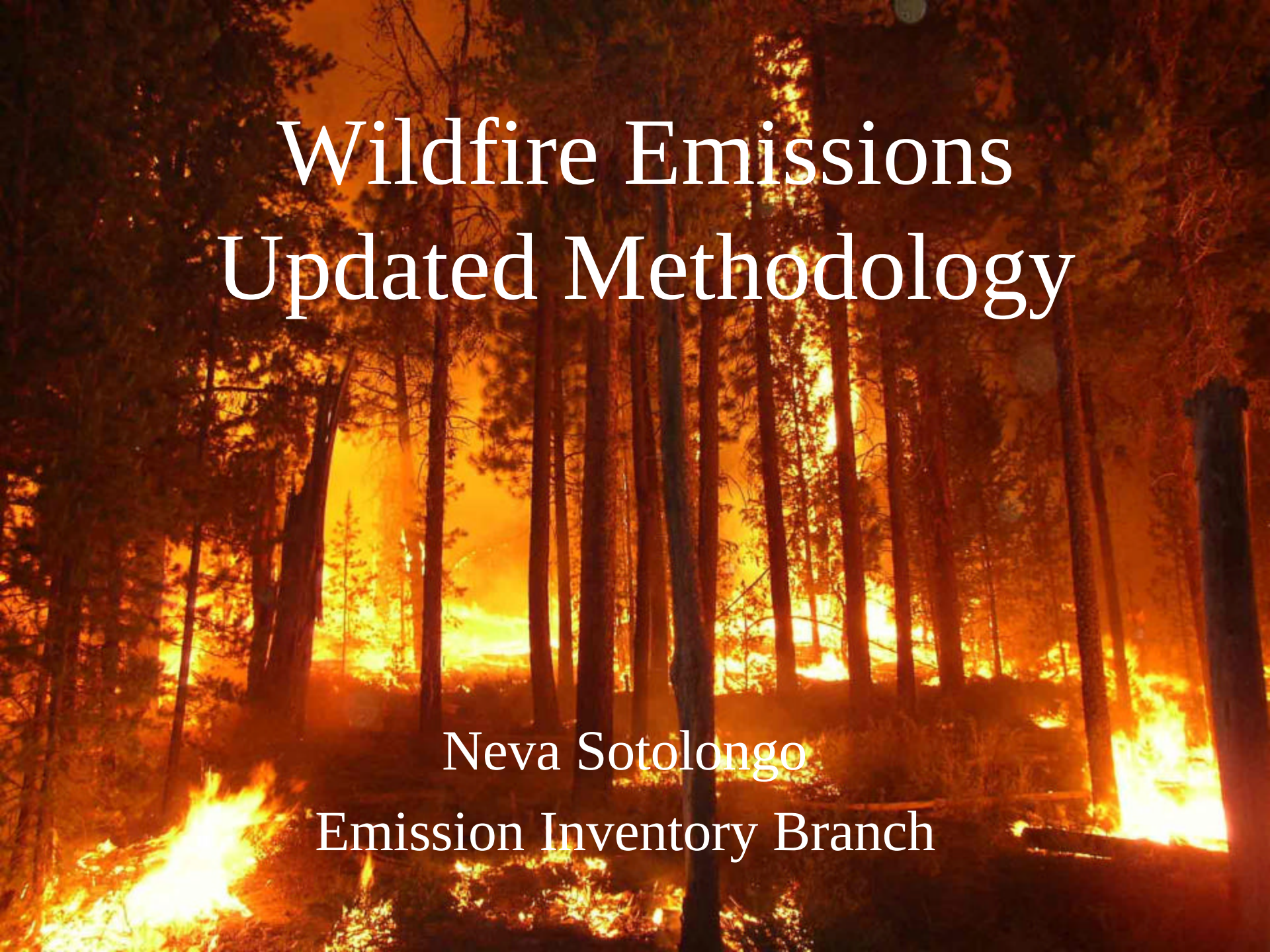


Wildfire Emissions Updated Methodology

Neva Sotolongo

Emission Inventory Branch

Overview

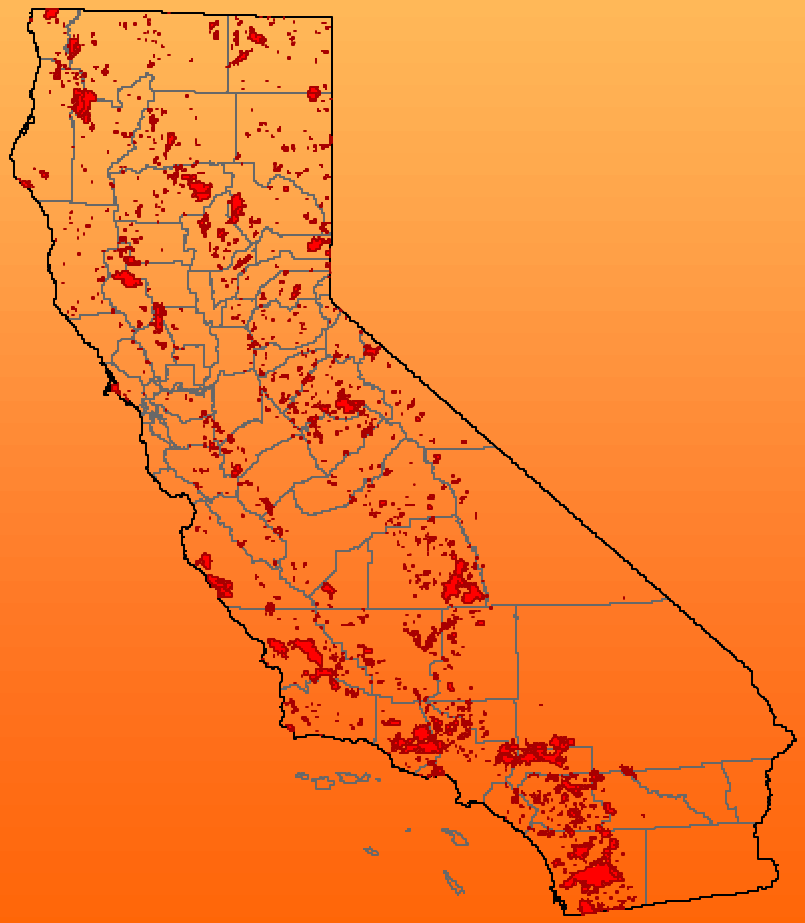
- Emission Estimation Model (EES)
  - GIS based model
  - Source data - FRAP
  - Emission calculation methodology - FOFEM
  - Seasonal variation - fuel moisture inputs
  - Example - Rumsey Fire
- Changes and assumptions in methodology
- Results

Wildfire Definition

A natural event that burns a variety of vegetation types ranging in age, size & density; caused by a variety of natural and human activity like lightning or arson and suppressed by fire fighters. This category does not include prescribed burns or WFU fires.

Source Data

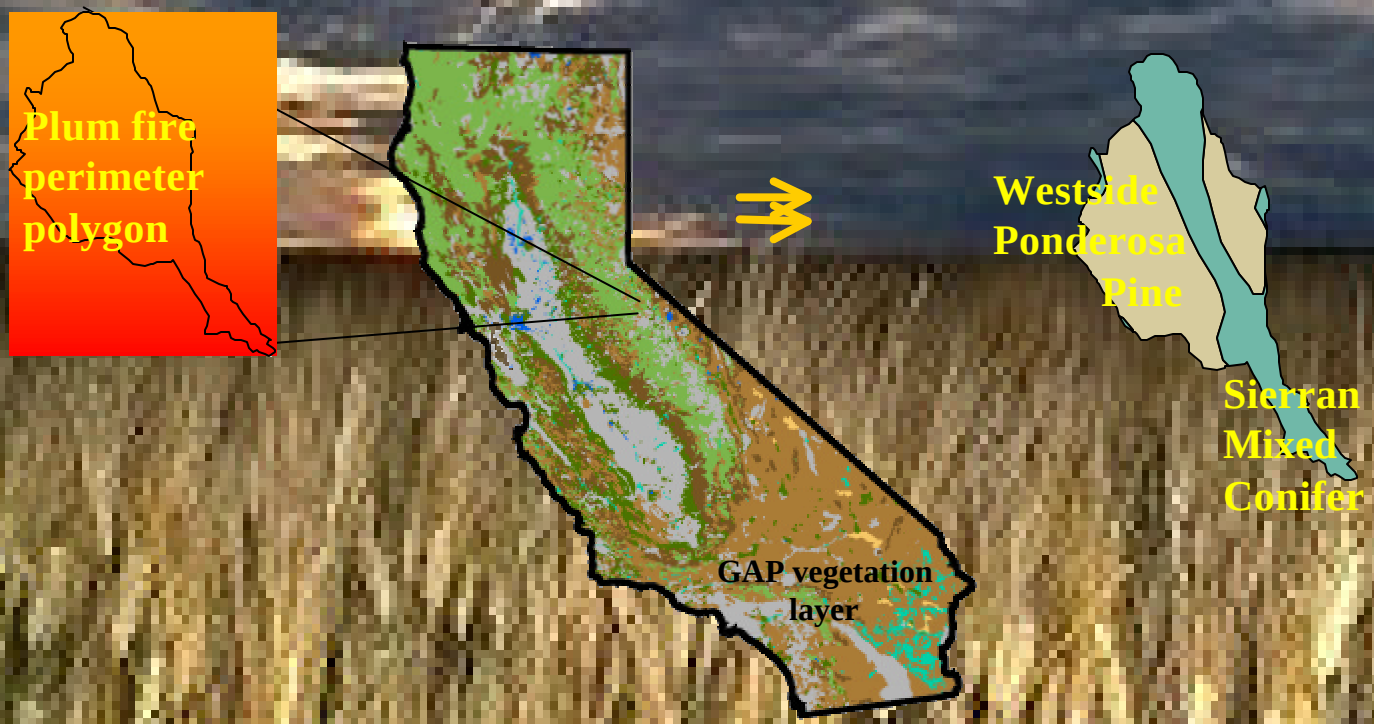
- Wildfire Dataset
  - FRAP dataset 1994-2003
  - Augmented
    - NPS fires
    - Flag WFU
    - Added missing data - dates
  - 2,500 fires 1994-2003
  - updated annually
  - most comprehensive dataset available
  - duplicate fire resolution
- Limitations



Emission Estimation

- CAMFER EES - GIS based emission estimation model designed for California
  - FOFEM - smoke emission estimation methodology
  - GAP Layer - vegetation landcover of CA
  - Thousand-Hour Fuel Moisture Grid - moisture input

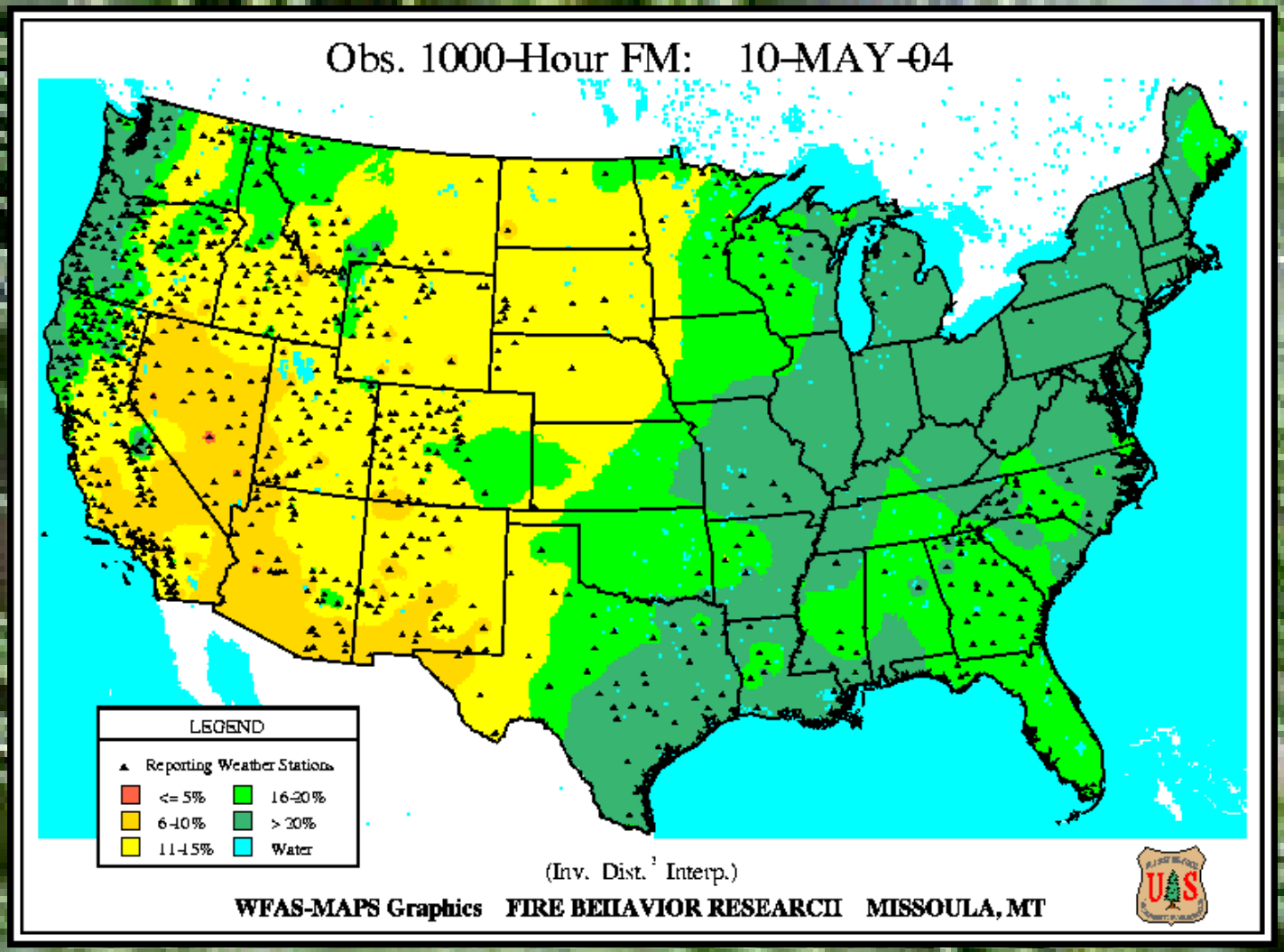
Wildfire footprint is overlaid on GAP vegetation layer, calculating the amount of each fuel consumed in the fire. Fuel loading is assigned for each fuel component that make up the vegetation type.



Fuel Components

		Sierra Nevada Mixed Conifer	
Fuel Component	**Consumption Assumption**	***Fuel Loading***	***Total Consumed***
Litter	100%	*1.8*	*1.8*
Wood 0-1 inch	90%	*1.3*	*1.2*
Wood 1-3 inch	65%	*1.9*	*1.2*
Wood 3+ inch	NFDR-TH	*32.0*	NFDR-TH
Duff	NFDR-TH	*56.0*	NFDR-TH
Herbaceous	100%	*0.2*	*0.2*
Shrub	60%	*0.3*	*0.2*
Tree regeneration	60%	*0.1*	*0.1*
Canopy branchwood	50%	*3.0*	*1.5*
Canopy foliage	100%	*6*	*6.0*

Thousand-Hour Fuel Moisture



TH-HR Fuel Moisture

Sierra Nevada Mixed Conifer					
Fuel Component	***Fuel Loading***	***Moisture Content***	***Flaming***	***Smoldering***	***Total Consumed***
Litter	*1.8*	--	--	--	*1.8*
Wood 0-1 inch	*1.3*	--	--	--	*1.2*
Wood 1-3 inch	*1.9*	--	--	--	*1.2*
Wood 3+ inch	*32.0*	*10.0*	*21.5*	*5.4*	26.9
Duff	*56.0*	*40.0*	*15.5*	*23.2*	38.7
Herbaceous	*0.2*	--	--	--	*0.2*
Shrub	*0.3*	--	--	--	*0.2*
Tree regeneration	*0.1*	--	--	--	*0.1*
Canopy branchwood	*3.0*	--	--	--	*1.5*
Canopy foliage	*6*	--	--	--	*6.0*

Emission Factors

(lbs/ton)

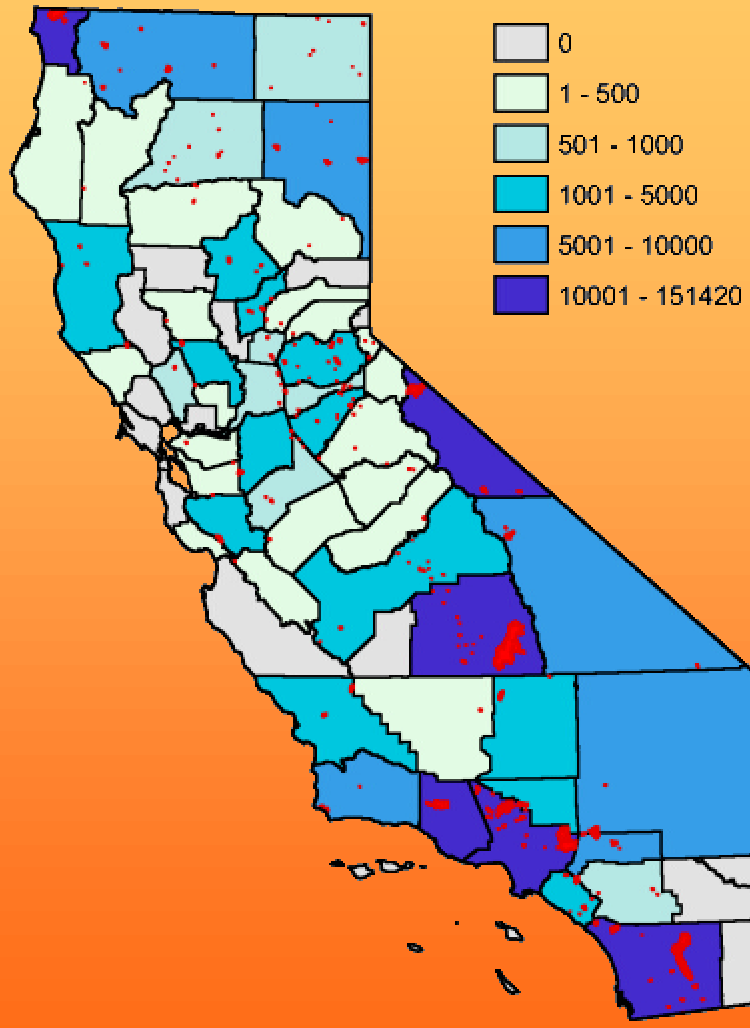
Fuel component	PM10			PM2.5			CO			CH4		
	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry
Litter, wood 0-1 in	9.3	9.3	9.3	7.9	7.9	7.9	52.4	52.4	52.4	2.1	2.1	2.1
Wood 1-3 in	14.0	14.0	14.0	11.9	11.9	11.9	111.4	111.4	111.4	4.5	4.5	4.5
Wood 3+ in	26.6	21.6	19.1	22.5	18.3	16.2	268.9	205.8	174.4	10.8	8.2	7.0
Herb, shrub, regen	25.1	25.1	25.1	21.3	21.3	21.3	249.2	249.2	249.2	10.0	10.0	10.0
Duff	28.2	30.4	30.4	23.9	25.8	25.8	288.6	316.1	316.1	11.5	12.6	12.6
Canopy fuels	25.1	25.1	25.1	21.3	21.3	21.3	249.2	249.2	249.2	10.0	10.0	10.0
	TNMHC			NH3			NOx			SO2		
Fuel component	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry	Wet	Mod	Dry
Litter, wood 0-1 in	3.7	3.7	3.7	0.5	0.5	0.5	8.2	8.2	8.2	2.5	2.5	2.5
Wood 1-3 in	7.8	7.8	7.8	1.1	1.1	1.1	8.0	8.0	8.0	2.5	2.5	2.5
Wood 3+ in	18.8	14.4	12.2	2.7	2.1	1.7	7.3	7.6	7.7	2.2	2.3	2.4
Herb, shrub, regen	17.4	17.4	17.4	2.5	2.5	2.5	7.4	7.4	7.4	2.3	2.3	2.3
Duff	20.2	22.1	22.1	2.9	3.2	3.2	7.2	7.1	7.1	2.2	2.2	2.2
Canopy fuels	17.4	17.4	17.4	2.5	2.5	2.5	7.4	7.4	7.4	2.3	2.3	2.3

Plum Fire PM10 Calculations

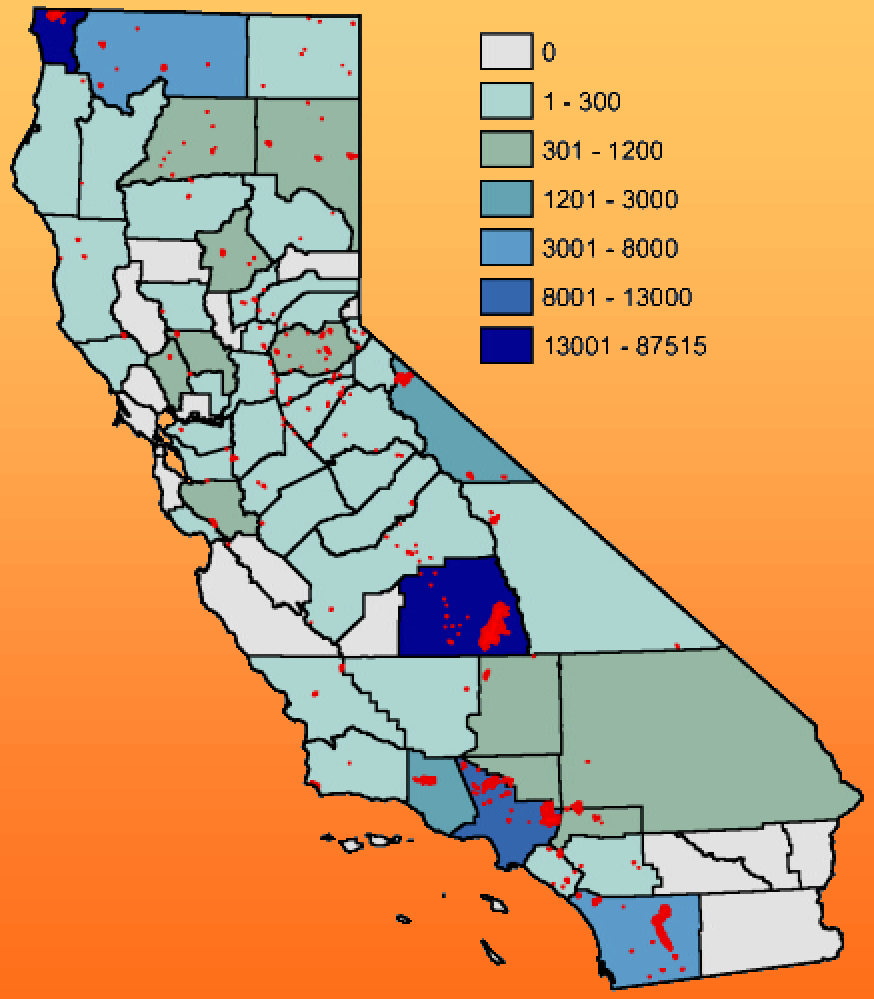
Fuel Component	Westside Ponderosa Pine	Sierran Mixed Conifer
Acres	**1,012**	**750**
	Fuel Loading (tons/acre)	
Litter	1.40	1.50
Wood 0-1 inch	0.70	1.00
Wood 1-3 inch	0.80	1.50
Wood 3+ inches	5.00	20.00
Herbs	0.20	0.20
Shrubs	0.25	0.25
Regen	0.15	0.15
Duff	5.00	40.00
Canopy foliage	6.00	6.00
Canopy branchwood	0.70	3.00

Fuel Component	Westside Ponderosa Pine	Sierran Mixed Conifer	Plum Fire Total Fuel Loading (tons)	Fuel Consumption (percent)	Fuel Consumed (tons)	PM10 Emission Factors (lbs/ton)	PM10 Emissions (lbs)	PM10 Emissions (tons)
	Acres * Fuel Loading							
Litter	1,416.8	1,125.0	2,541.8	100%	2,541.8	9.3	23,638.7	11.8
Wood 0-1 inch	708.4	750.0	1,458.4	90%	1,312.6	9.3	12,206.8	6.1
Wood 1-3 inch	809.6	1,125.0	1,934.6	65%	1,257.5	14.0	17,604.9	8.8
Wood 3+ inches	5,060.0	15,000.0	20,060.0	82%(1)	16,451.6	19.1(3)	314,225.0	157.1
Herbs	202.4	150.0	352.4	100%	352.4	25.1	8,845.2	4.4
Shrubs	253.0	187.5	440.5	60%	264.3	25.1	6,633.9	3.3
Regen	151.8	112.5	264.3	60%	158.6	25.1	3,980.4	2.0
Duff	5,060.0	30,000.0	35,060.0	34%(2)	12,088.7	30.4(3)	367,496.1	183.7
Canopy foliage	6,072.0	4,500.0	10,572.0	100%	10,572.0	25.1	265,357.2	132.7
Canopy branchwood	708.4	2,250.0	2,958.4	50%	1,479.2	25.1	37,127.9	18.6
							Total	528.6

Acres Burned 2002

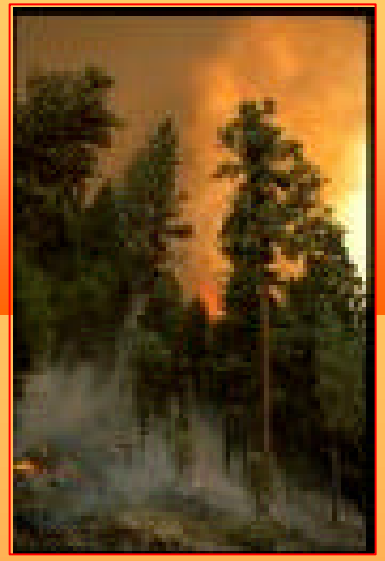


PM10 Emissions 2002

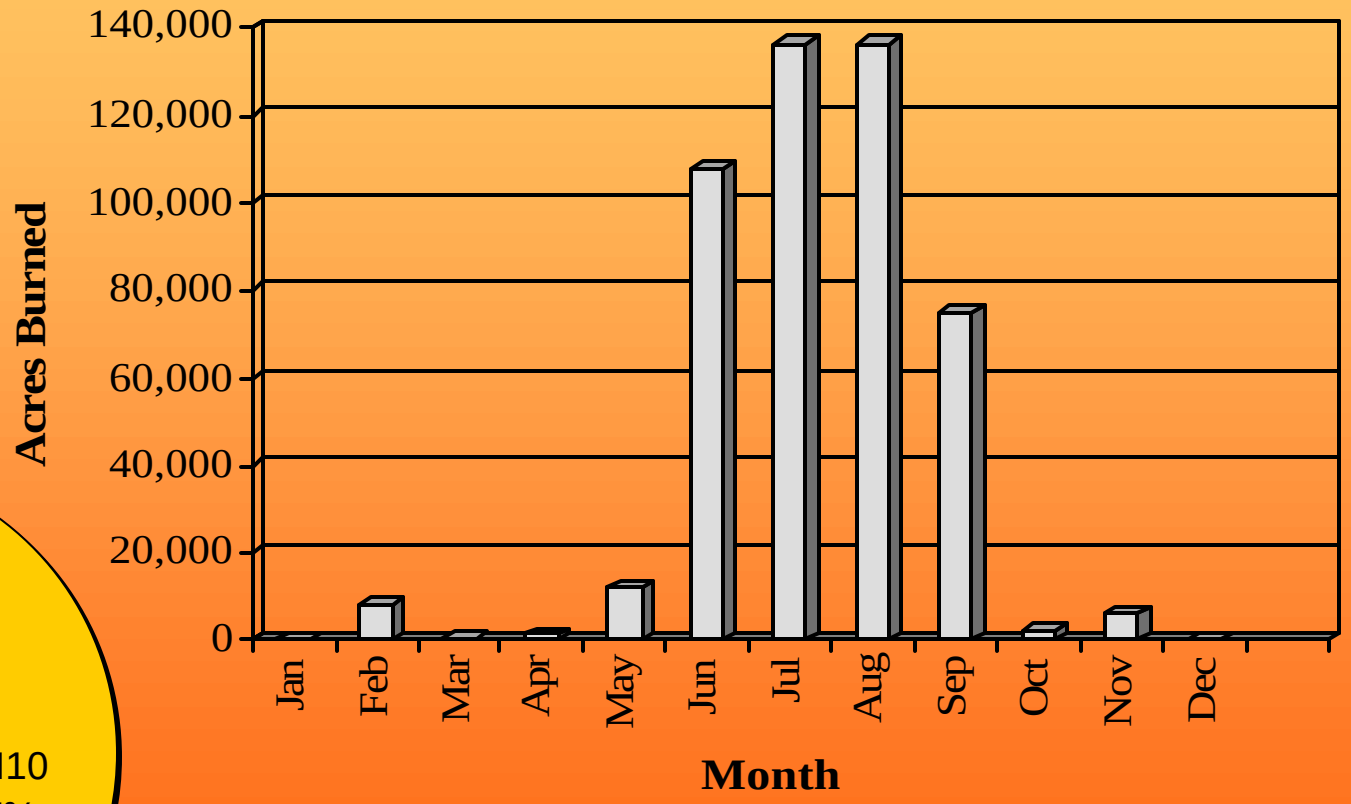


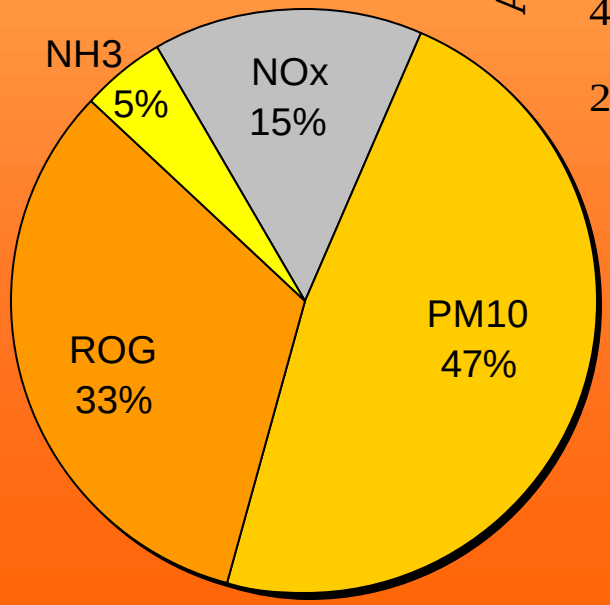
WFUs

- Wildland Fire Use Fires
  - lightning ignited fires managed for resource benefit
- Flagging WFUs - contacted individual agencies
- 80 WFUs between 1994-2003
  - 88,900 acres
- 22 WFUs in 2003
  - 44,500 acres
  - ~5% of wildfires



Seasonal Variation & Pollutant Proportions





Assumptions

- Gridded NFDR-TH moisture - 2002
- Distribution of zero months
- FOFEM method assumes 100% of burn area experiences fire
- Dataset limitations

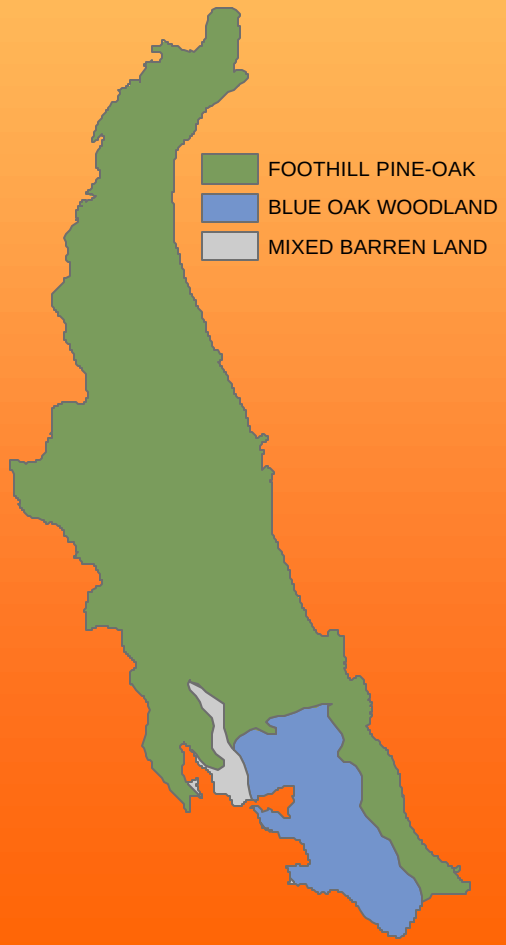
Methodology

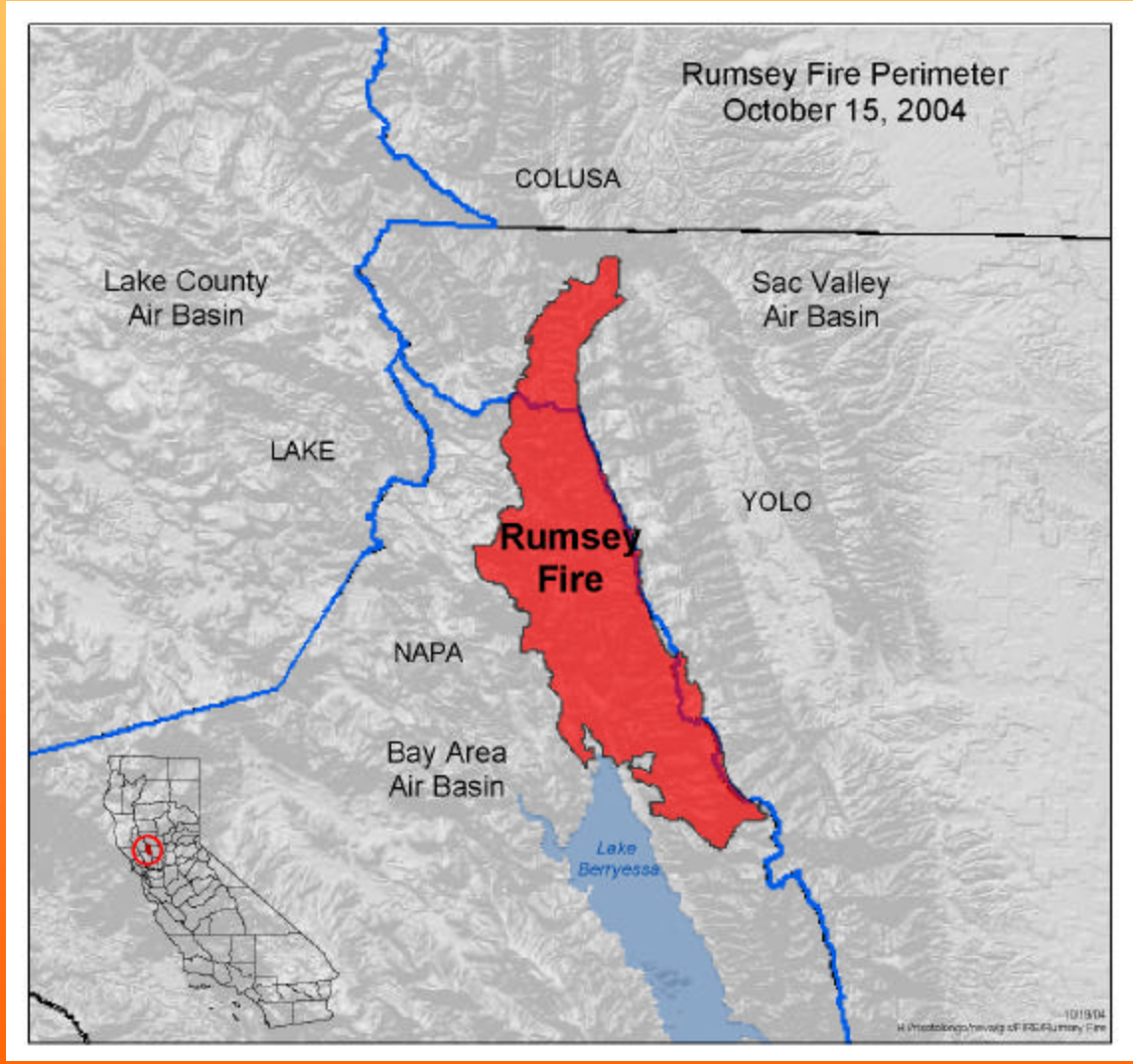
- GIS ability to grid emissions for modeling
- 2004 Almanac uses 10 year average
  - CEIDARS has actual 1994 - 2003 fire emissions
  - CEFS projections are based on 10 year average
- Future updates
  - Prescribed burn emissions
  - Agricultural burn emission

Changes to Methodology

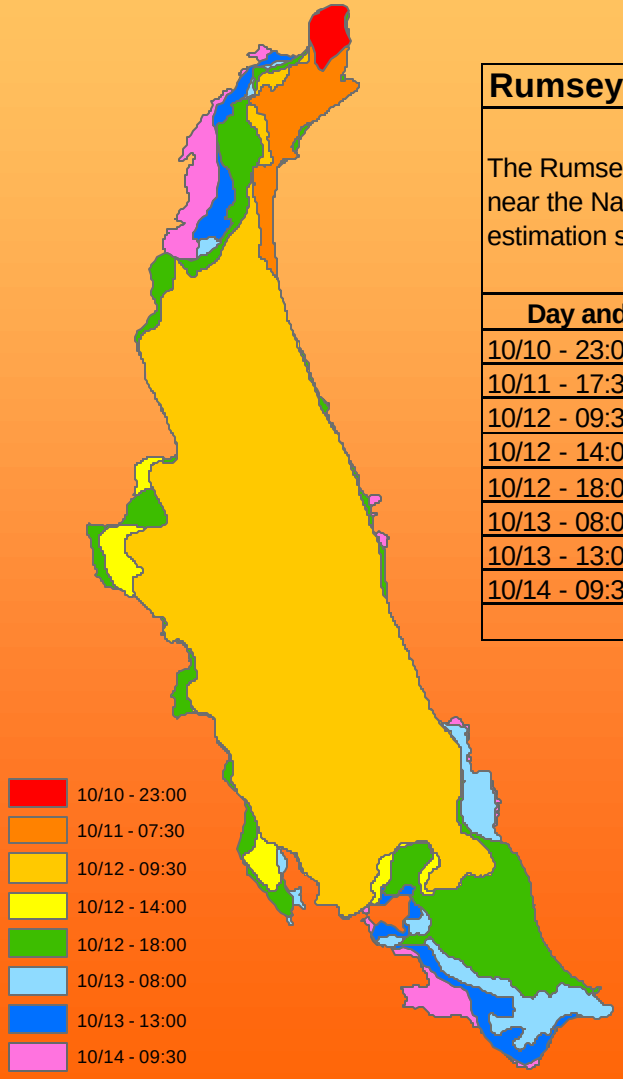
- Combined EIC (CES) codes - “All Vegetation”
  - “Grass and Woodlands” and “Timber and Brush”
- Actual fire perimeters and location
- Vegetation specific emission estimates

Rumsey Fire Emissions





Rumsey Fire Emission Estimates



Rumsey Fire Emission Estimates

The Rumsey fire burned approximately 39,000 acres October 10-14, 2004. The fire was primarily in Napa County near the Napa-Yolo county line. Fire emission were calculated using the ARB's GIS based wildfire emission estimation system (EES) model. Daily

Day and Time	Acres	PM10	PM25	CO	CH4	TNMHC	NH3	NOx	SO2
10/10 - 23:00	380	168	143	1,644	66	115	16	53	16
10/11 - 17:30	1,530	677	574	6,621	265	463	66	213	66
10/12 - 09:30	26,200	10,760	9,130	105,246	4,210	7,367	1,052	3,390	1,044
10/12 - 14:00	981	349	296	3,413	137	239	34	111	34
10/12 - 18:00	5,396	1,715	1,455	16,740	670	1,172	167	544	168
10/13 - 08:00	1,905	499	423	4,861	194	340	49	159	49
10/13 - 13:00	1,452	314	266	3,052	122	214	31	101	31
10/14 - 09:30	1,549	477	404	4,651	186	326	47	152	47
TOTAL	**39,393**	**14,958**	**12,692**	**146,228**	**5,849**	**10,236**	**1,462**	**4,722**	**1,455**

Contact Information

Neva Sotolongo
Air Resources Board
(916) 323-4887
nsotolon@arb.ca.gov