EPA's Air QUAlity TimE Series: A Multi-Year Reanalysis of EPA's Fire Emissions Inventory

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Background

- EPA's air QUAlity TimE Series: a multiyear set of emissions 2002-2017
- Biomass burning inventory includes
  - wildfires
  - prescribed fires
  - cropland fires
  - grass or rangeland fires (including Flint Hills)

Source:https://inciweb.nwcg.gov/incident/photograph/7152/59/105237

Source:https://www.nps.gov/articles/images/SARA-RxFire.jpg

Source: http://www.golfbytourmiss.com/gbtm/wp-content/uploads/2014/12/Florida-sugarcane-fire..jpg
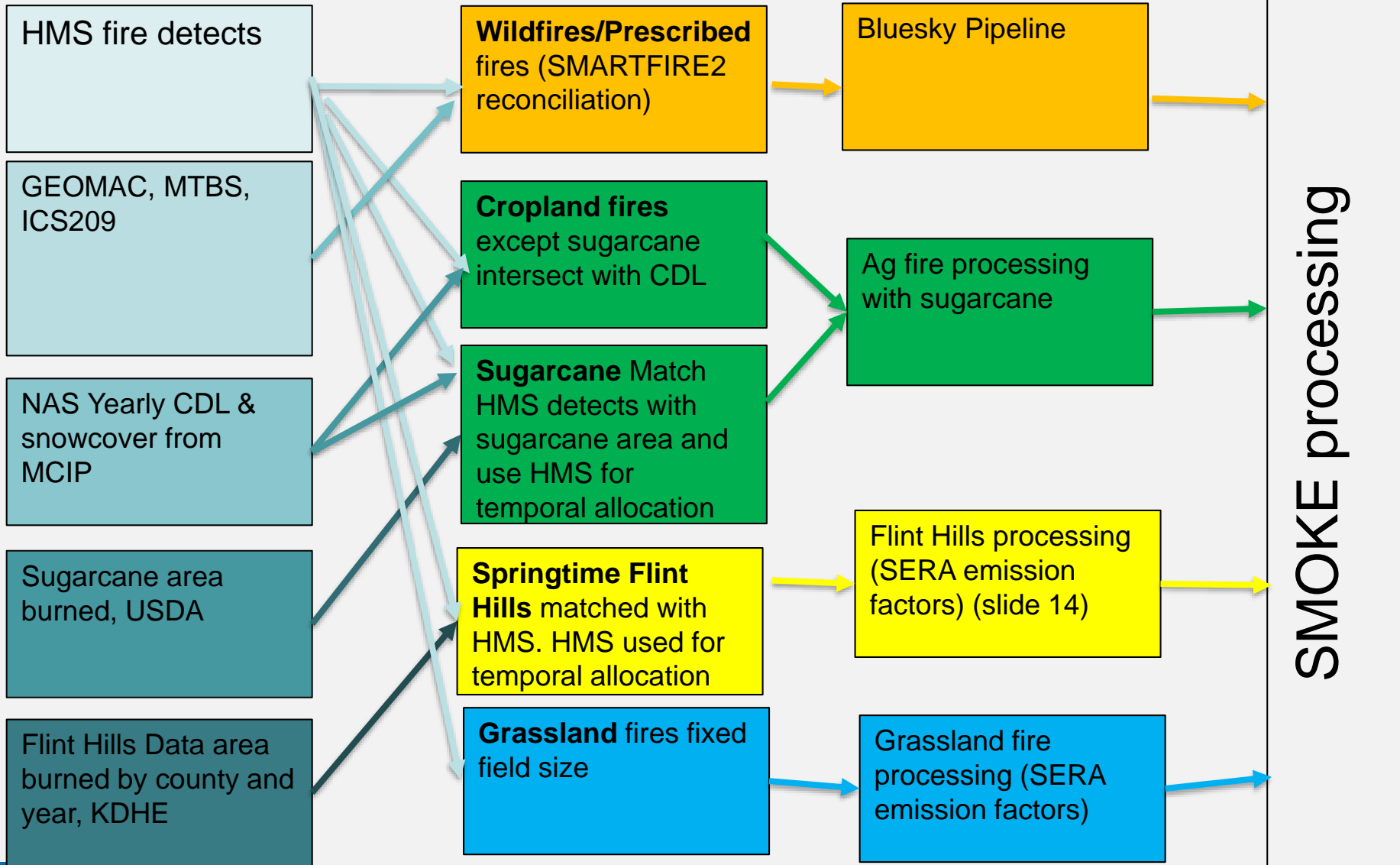
Objectives

- Summarize method used to process and estimate area burned and emissions

- Compare area burned with existing datasets

- Provide explanations for differences

EQUATES

Overview of Emission Processing

- Four sources of CONUS wildfire/prescribed fire:
  - ➤ Hazard Mapping System (HMS) fire detections
  - ➤ GEOspatial Multi-Agency Coordination (GEOMAC)
  - ➤ Monitoring Trends in Burn Severity (MTBS)
  - ➤ InCident Status summary (ICS) 209 Reports

- Two sources of very specific data:
  - ➤ Acres harvested for sugarcane (USDA)
  - ➤ Area burned Flint Hills (KS and few OK counties) (KDHE)

EQUATES

Overview of Emission Processing

- HMS data intersected with year-specific NAS Cropland Data Layer (CDL) to categorize a fire detection:
  - (1) cropland, (2) grassland, or (3) wildfire/prescribed fire
- HMS grassland detects compared to location/timing of spring burning in Flint Hills
- Remaining detects reconciled with the 3 other datasets (GEOMAC, MTBS, ICS209) in SMARTFIRE2 to estimate wildfires and prescribed fires area burned
- Five fire types:
  - wildfires, prescribed fires, cropland fires, grassland fires, springtime Flint Hills fires

EQUATES

Data Flow

HMS fire detects

GEOMAC, MTBS, ICS209

NAS Yearly CDL & snowcover from MCIP

Sugarcane area burned, USDA

Flint Hills Data area burned by county and year, KDHE

Wildfires/Prescribed fires (SMARTFIRE2 reconciliation)

Bluesky Pipeline

Cropland fires except sugarcane intersect with CDL

Sugarcane Match HMS detects with sugarcane area and use HMS for temporal allocation

Ag fire processing with sugarcane

Springtime Flint Hills matched with HMS. HMS used for temporal allocation

Flint Hills processing (SERA emission factors) (slide 14)

Grassland fires fixed field size

Grassland fire processing (SERA emission factors)

SMOKE processing

EQUATES

NOAA Hazard Mapping System (HMS)

- Daily fire locations from both geostationary and polar orbiting satellites (GOES, MODIS, VIIRS).

- Quality checked by a satellite analyst daily. Analysts attempt to distinguish fires from heat sources or highly reflective surfaces, such as factories, mines, gas flares, solar panels, clouds.

- Dataset available from 2003-2017. Recent years (2016+) include VIIRS and next generation of GOES.

EQUATES

Wildfire, Prescribed Fire method for 2004-2017: SMARTFIRE2

- 4 input datasets (HMS, ICS209, MTBS,GEOMAC)

- ICS planned ignition report tables not used

- Previously only duplicates at the exact location, date, and time were dropped. Now we drop HMS duplicates by location (rounded to +/- 0.001 degree lat or lon) and timezone adjusted date.

- ICS preprocessing now uses the 2016v1/2017 methods:
  - durations of wildfires scaled based on the size of the fire.

EQUATES

Wildfire, Prescribed Fire method for 2004-2017: SMARTFIRE2 (continued)

- SMARTFIRE2 has different reconciliation settings that can change how activity is split and grouped. Example: which dataset gets preference if there is a discrepancy in space or time.

- We are using Monitoring Trends in Burn Severity (MTBS) shapes, which includes both prescribed and wildfires.
  - MTBS has the highest ranked area in terms of SMARTFIRE2 reconciliation.
  - If MTBS reconciles with other fires, then the area from MTBS is used.
  - fires classified as unknown in the MTBS left out.
  - Many of the UNK are from the Flint Hills or they are prescribed.

Cropland Fire Process

- Use state-specific field size for all crop types except for sugarcane (Pouliot et al. 2017)

- Locate HMS detects with CDL layer to identify fire location, date, and crop type

- Sugarcane is a special case since it is a pre-harvest burning

  – acreage by year, state for sugarcane: USDA Annual Harvested Acres, available 2002-2019

  – cropland emission factors VOC & HAPs updates to reflect latest information in SPECIATE database

  – HMS data only used for temporal/spatial allocation: each HMS detect is assigned a fixed size per state per year: sum of (fire detect*acres/detect)= total annual acreage burned

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USDA Cropland Data Layer

- [USDA National Agricultural Statistics Service (NASS) Cropland Data Layer by year](#) (2008-2017).

- USDA generates year specific dataset from satellite imagery-based acreage estimates for major commodities and digital, crop-specific, categorized geo-referenced year specific datasets [Link for details](#)

- For years prior to 2008 (2003-2007), we re-used the 2008 dataset.

EQUATES

Method to Estimate Sugarcane Emissions

(1) Estimate acres burned from acres harvested with adjustments for fraction used for seeds, unharvested, or green-harvested.

(2) Compare to number of fire detections from remote sensing over sugarcane regions to compute a acres/pixel factor per year and per state

(3) Estimate annual area burned by state:

$$Area_s = (1\text{-fraction}_{greenharvested})*(Area_{planted}\text{-}Area_{seeds}\text{-}Area_{unharvested})$$

(4) $E_{p,s} = cc*Area_s*EF_p*FL$

where $E_{p,s}$ = emissions by pollutant and state (tons)

cc = combustion completeness (non-dimensional)

$Area_s$ = area burned per state (acres)

EF_p = emission factor by pollutant (lbs/ton)

FL = fuel loading (tons/acre)

EQUATES

Annual PM$_{2.5}$ Emissions from Sugarcane Burning
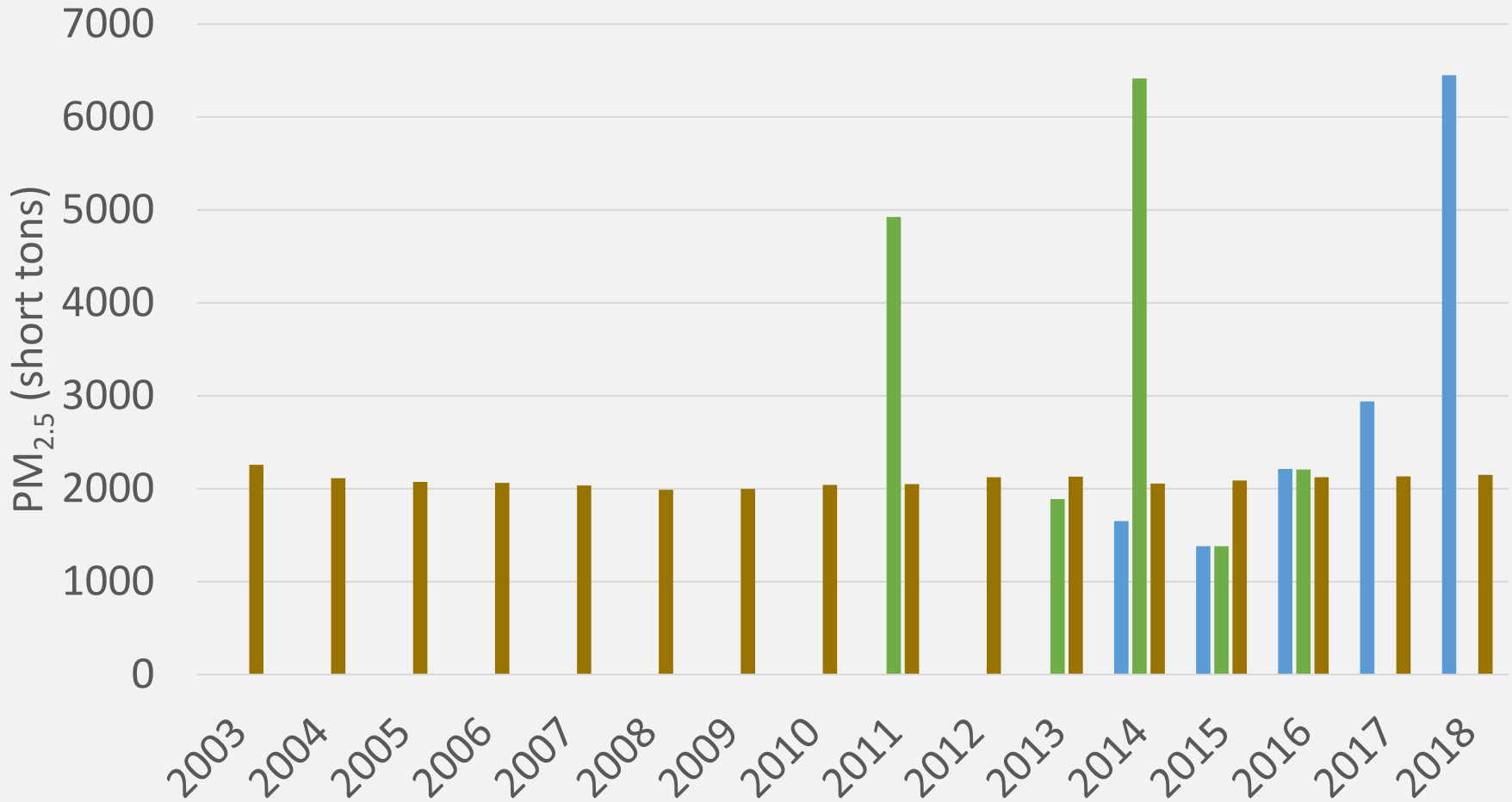
Springtime Flint Hills Fire and Grassland Fires Process

- Flint Hills unique SCC with grass emission factors from SERA and area burned constrained from Mohler and Goodin, 2012 (2002-2010), J. Prentice Memo (2011-2017)

- Grass Fires (excluding Flint Hills) calculated separately using SERA emission factors (100 acres per detect)

- Anderson Creek and 350 Complex excluded from 2016 since these were wildfires

- Spring period varies by year as defined by KDHE or from Mohler and Goodin paper, generally late Feb – early May.

Grassland emission factors – SERA

EQUATES

Method to Estimate Flint Hills Emissions

(1) Acres burned by county from KDHE (Jayson Prentice)

(2) Use the number of satellite fire detections over Flint Hills to compute an area/pixel factor by year and by county

(3) Estimate area burned by HMS pixel: $Area_{\text{pixel}} = (Area_{\text{county}})/(Area/pixel)$

(4) $E_{p,s} = cc*Area_{\text{pixel}}*EF_p*FL$
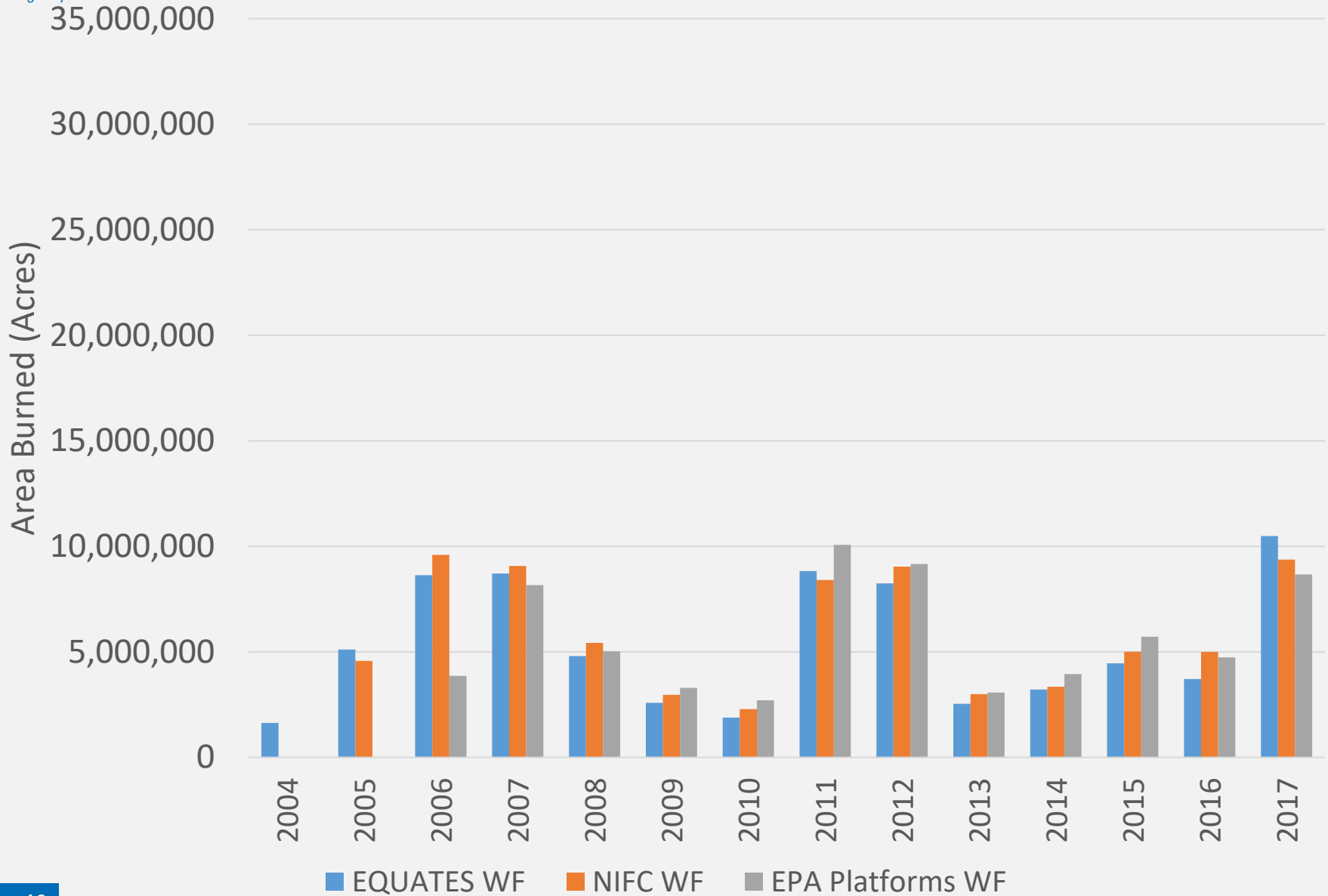
Where: $E_{p,s}$ = emissions by pollutant and pixel (tons)

cc = combustion completeness (non-dimensional)
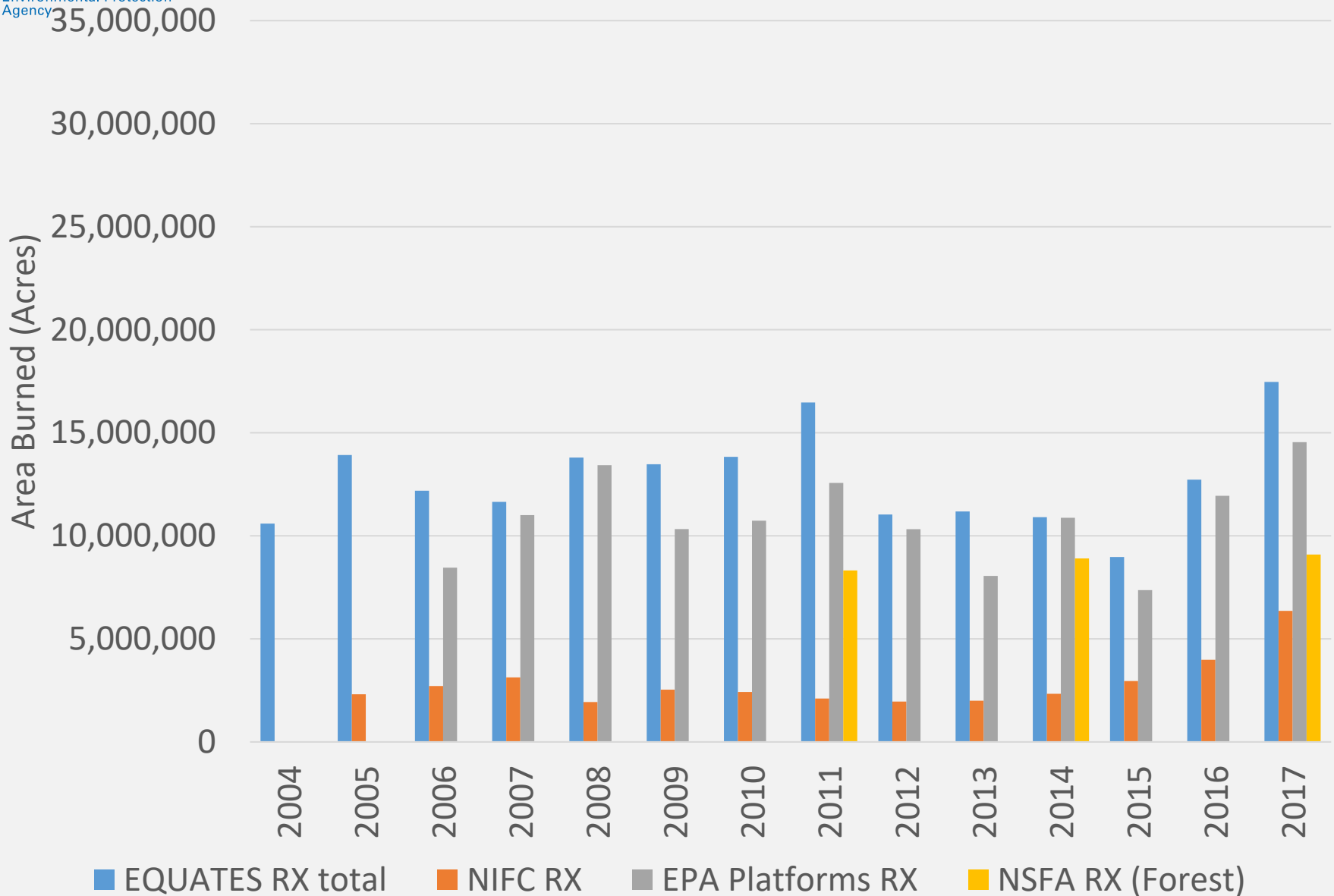
$Area_s$ = area burned per pixel (acres)

EF_p = emission factor by pollutant (lbs/ton) (SERA)
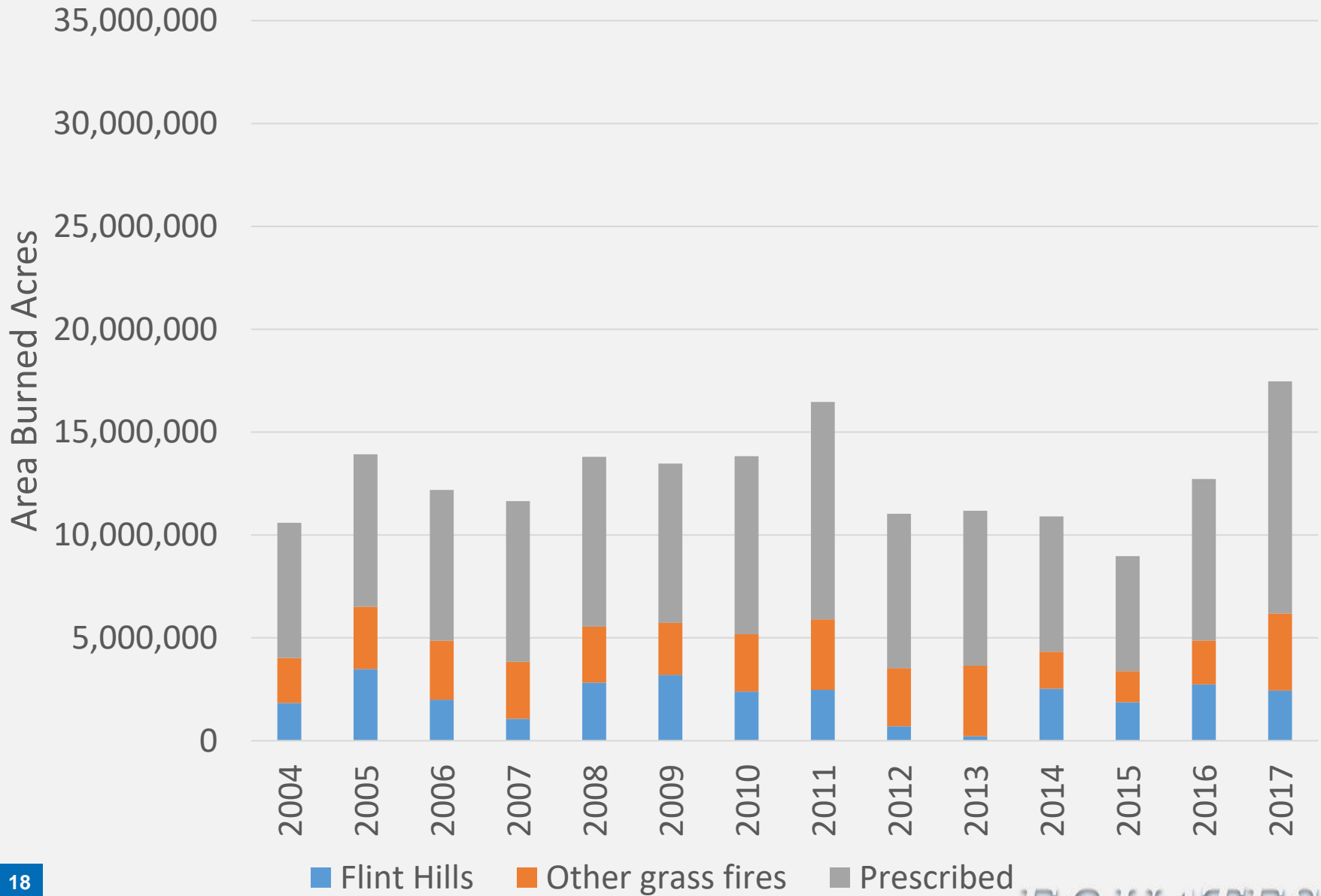
FL = fuel loading (tons/acre)

EQUATES

Estimated annual area burned from wildfire across the CONUS

EPA — United States Environmental Protection Agency
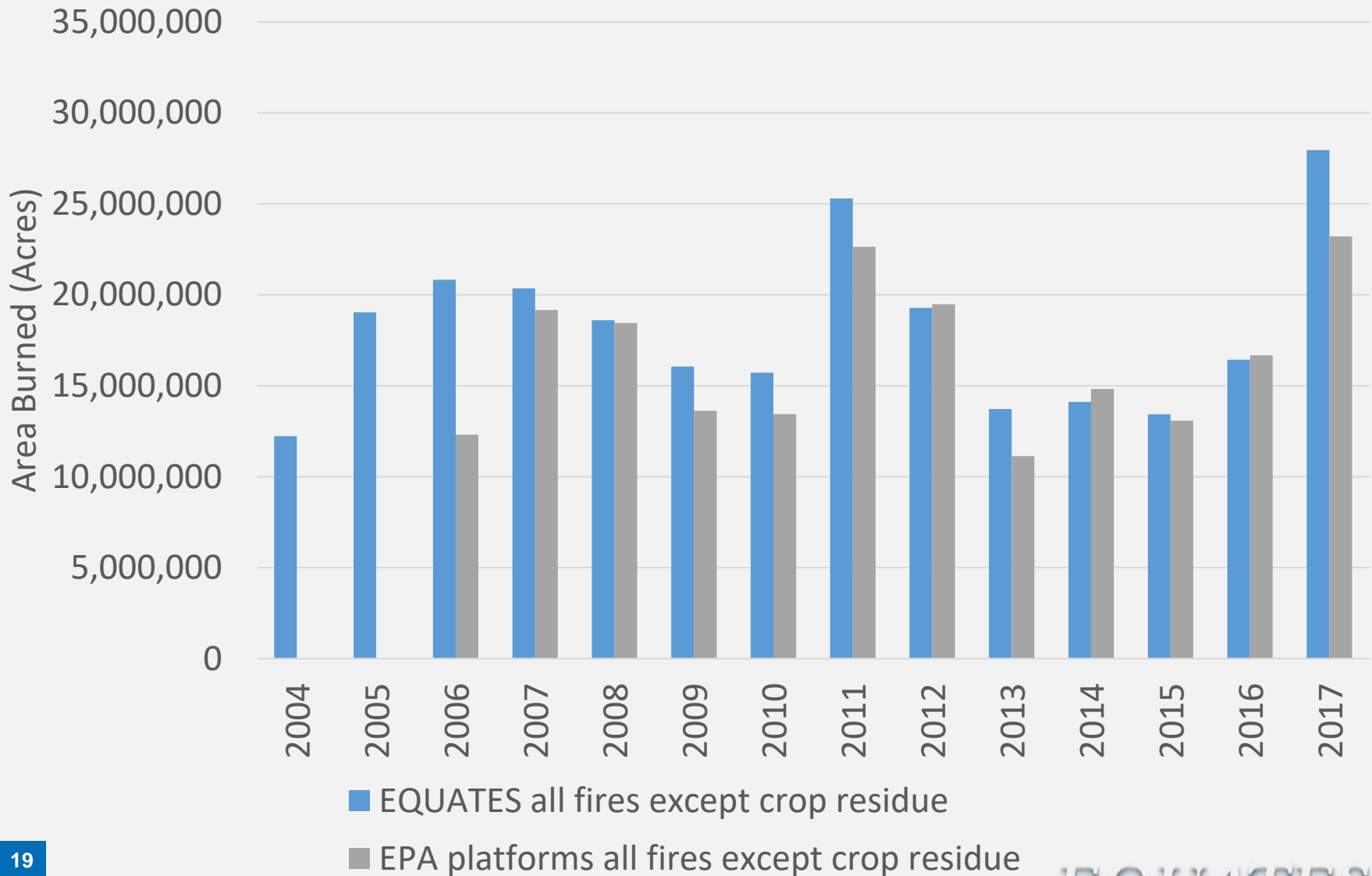
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EQUATES

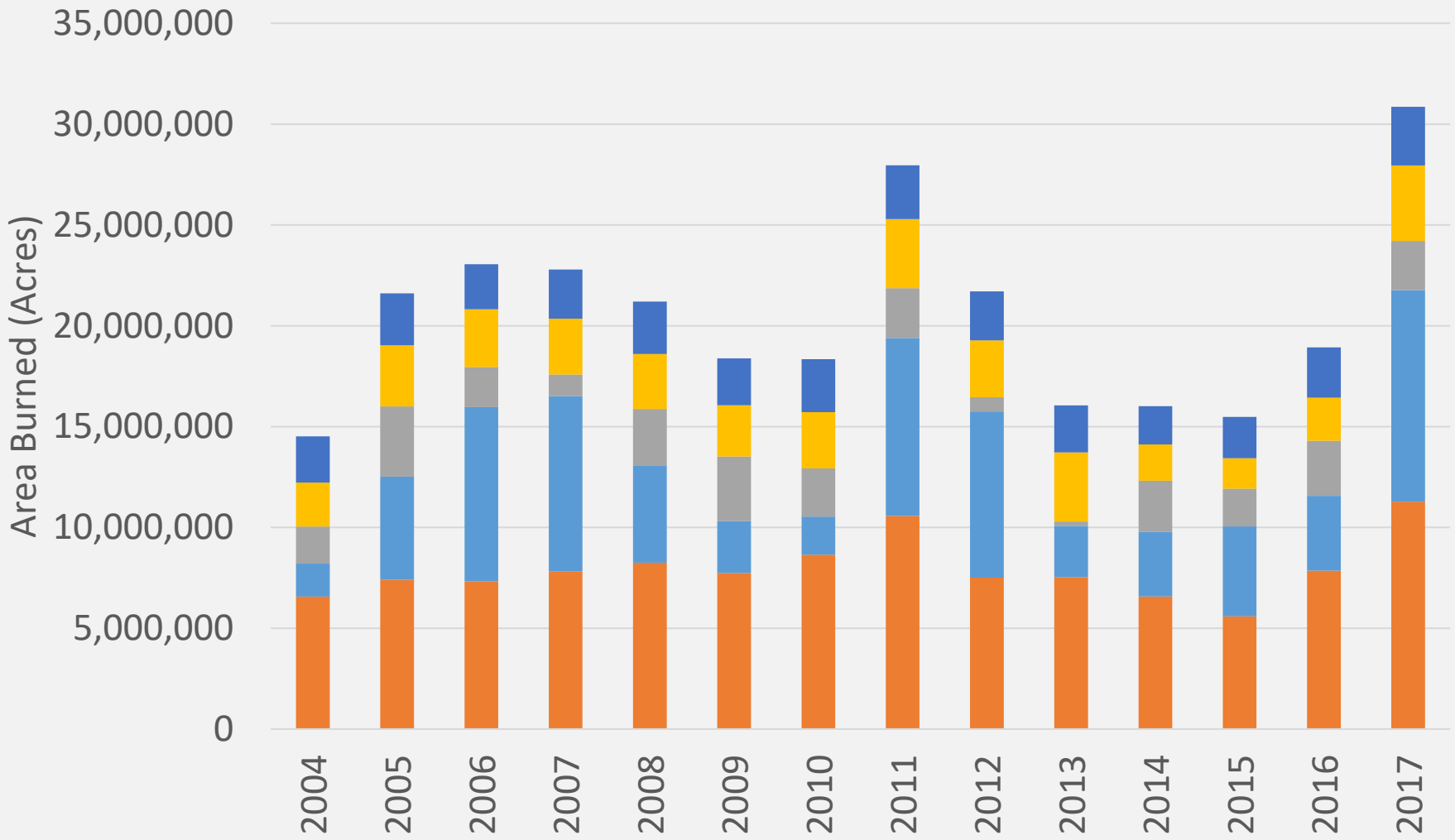CONUS area burned comparison Prescribed Fires 2004-2017

All Prescribed Fires 2004-2017 (EQUATES)

CONUS area burned comparison all fires except crop residue 2004-2017

EQUATES

EQUATES CONUS area burned all fires 2004-2017

Legend: Prescribed, Wildfire, Flint Hills, Other grass fires, Crop residue fires

Summary 1

- Wildfire area burned: consistent across all datasets
- Prescribed fires: much more area burned in EQUATES dataset because
  - assumptions about acres/pixels
  - existing datasets tend to underestimate these fires
- Flint Hills: first time we have developed consistent methods for the entire time series and used KDHE data
- Crop Residue: consistent methods applied for the first time for entire time series

- Temporal trend no longer contains artifacts for method changes

EQUATES

Summary 2

- EQUATES area burned has more acres compared to existing datasets because
  - Flint Hills acres included for every year
  - Prescribed fires are estimated with consistent methods for all years
- 100 acres/detect assumed for grass fires (generally prescribed fires)
  - Different assumption could increase/decrease acres
- Only 4 datasets used in SMARTFIRE2 even for NEI years.
- Results are different than 2016v1, 2017 NEI results with no state submitted inputs

EQUATES

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EQUATES