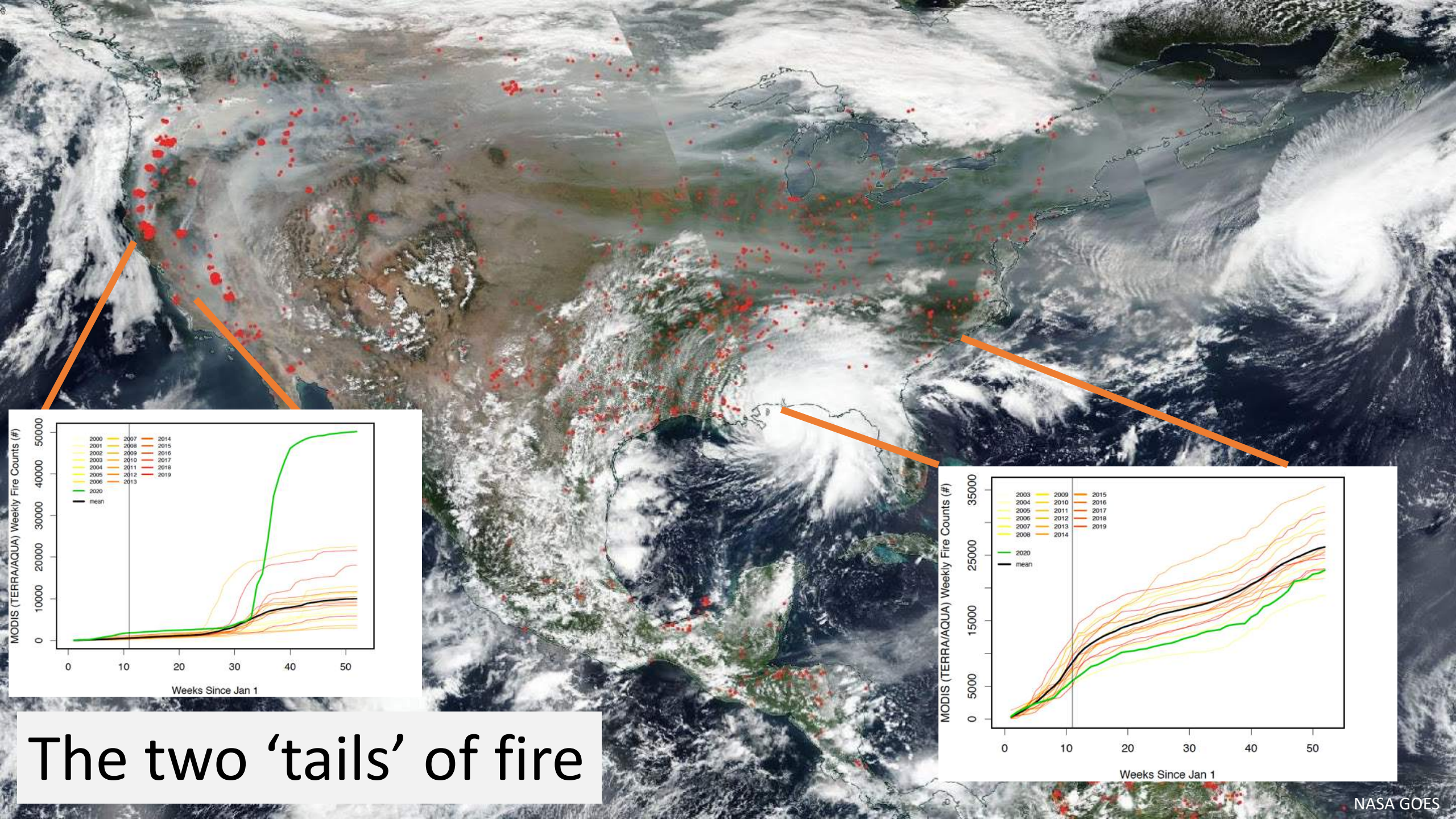
The imprint of COVID-19 on the 2020 prescribed fire season

Ben Poulter, Patrick Freeborn, Carlos Gaitan, Matt Jolly, Chris Lund, Joe Noble, Eli Simonson and Morgan Varner

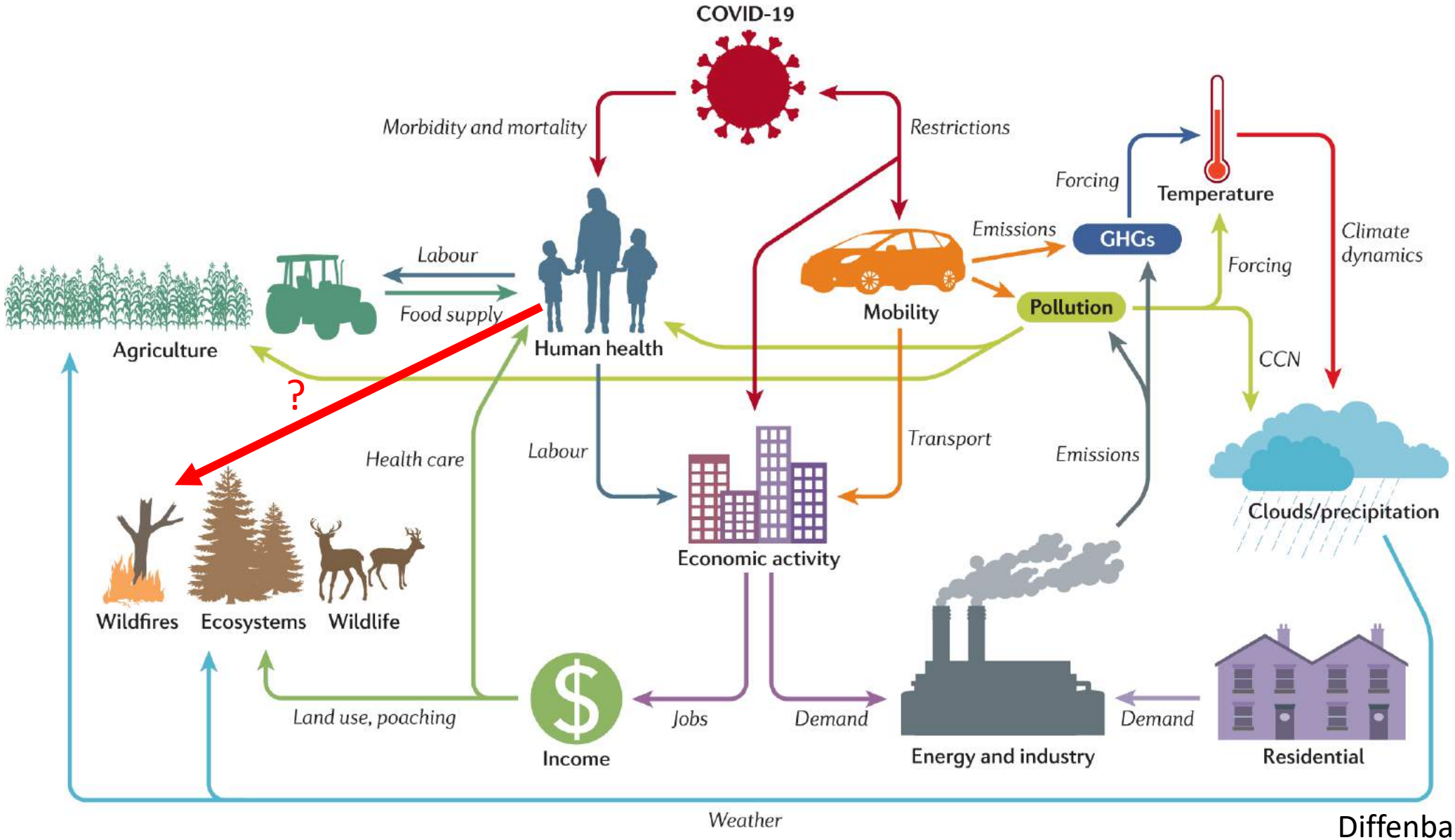
Photo: Tall Timbers



The two ‘tails’ of fire

NASA GOES

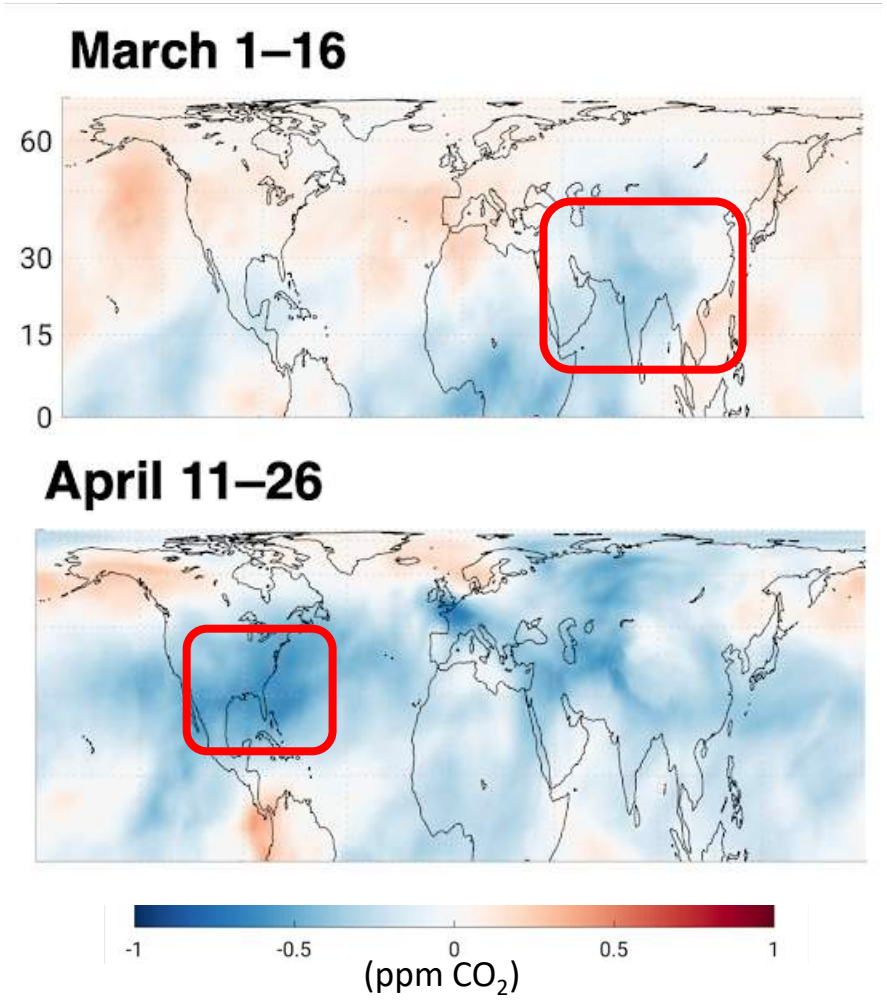
COVID19 and Earth System Responses



Diffenbaugh et al. 2020

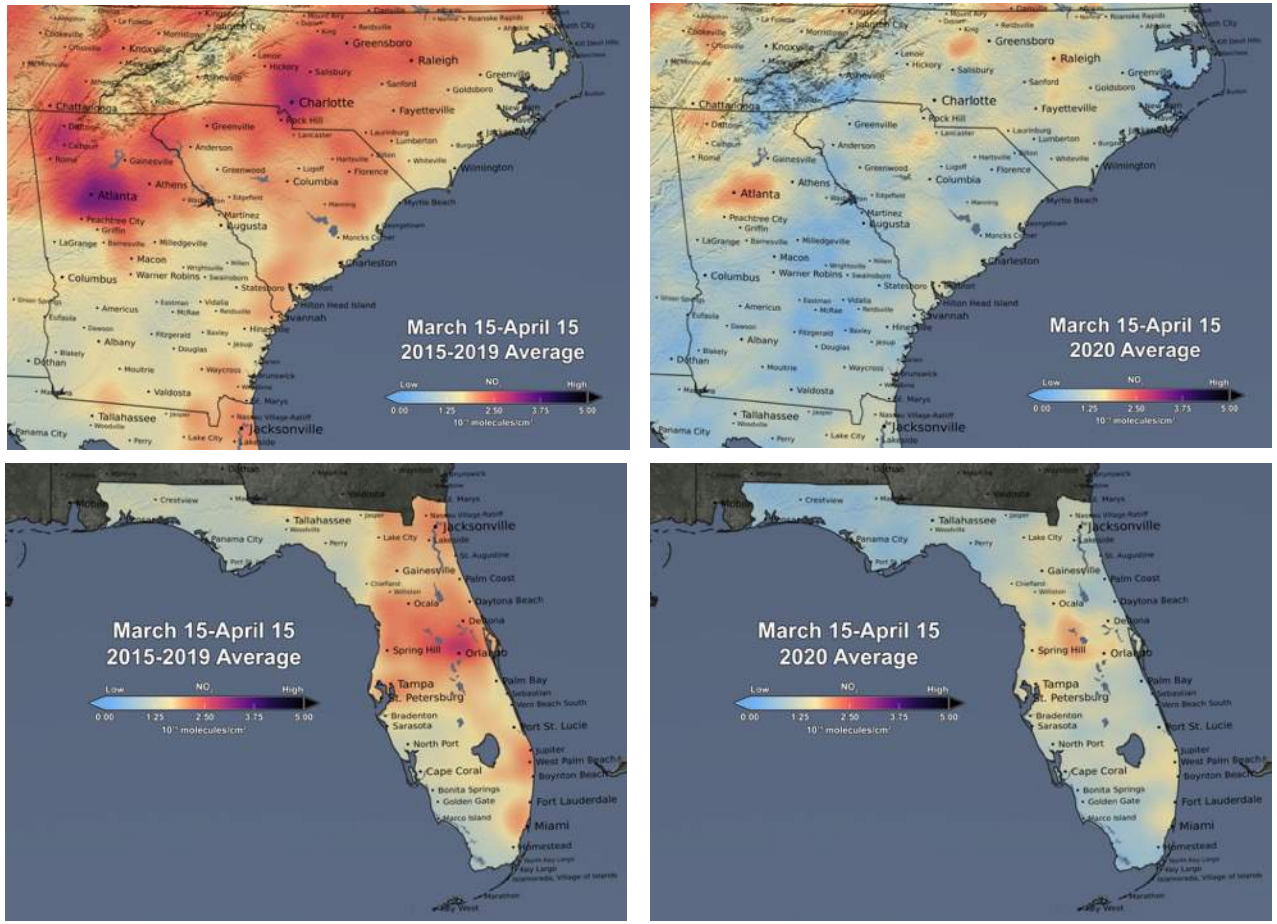
COVID19 and Earth System Responses

Springtime reductions atmospheric CO_2



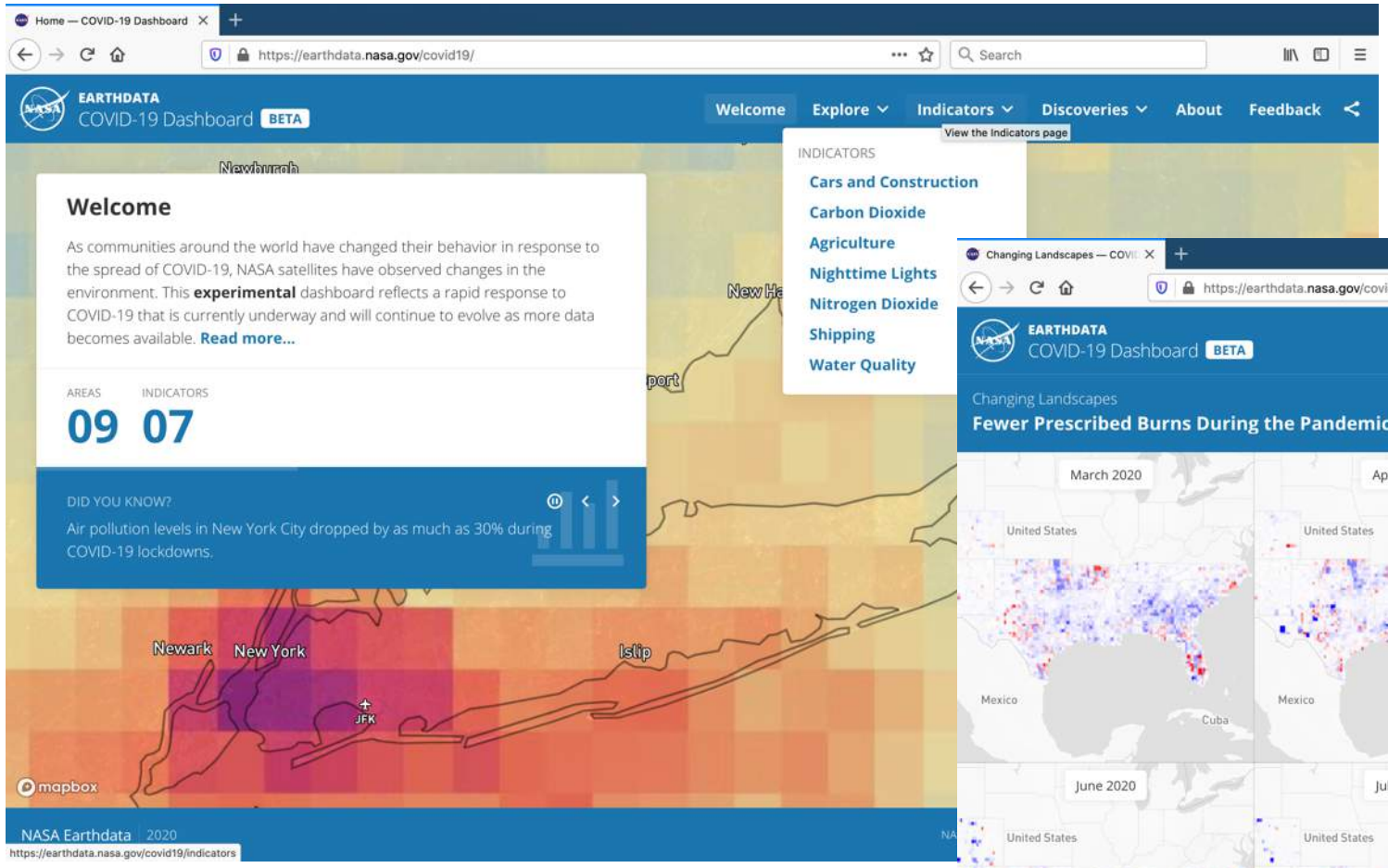
Weir et al. in rev

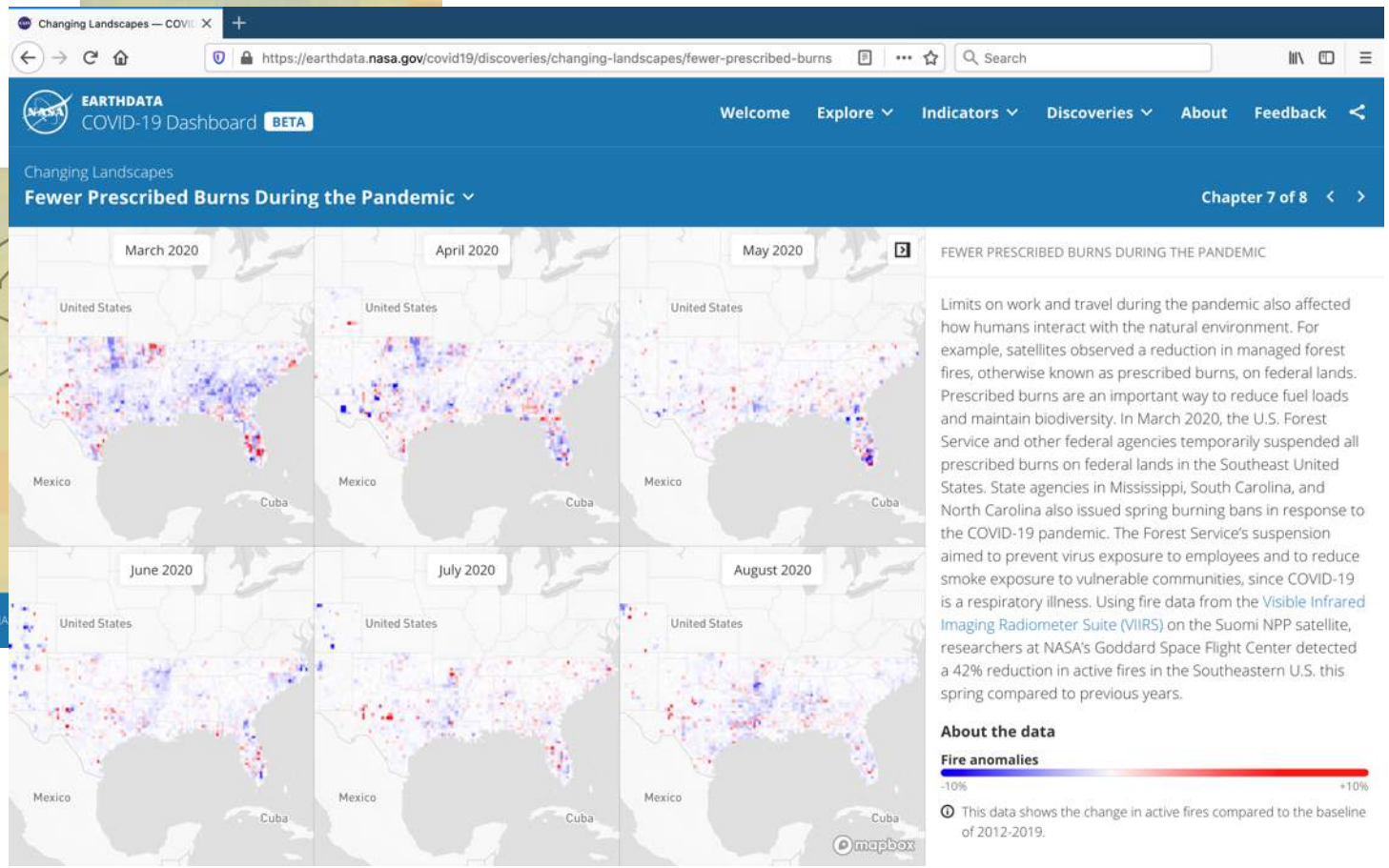
Reductions atmospheric NO_2



NASA OMI

COVID19 and Earth System Responses

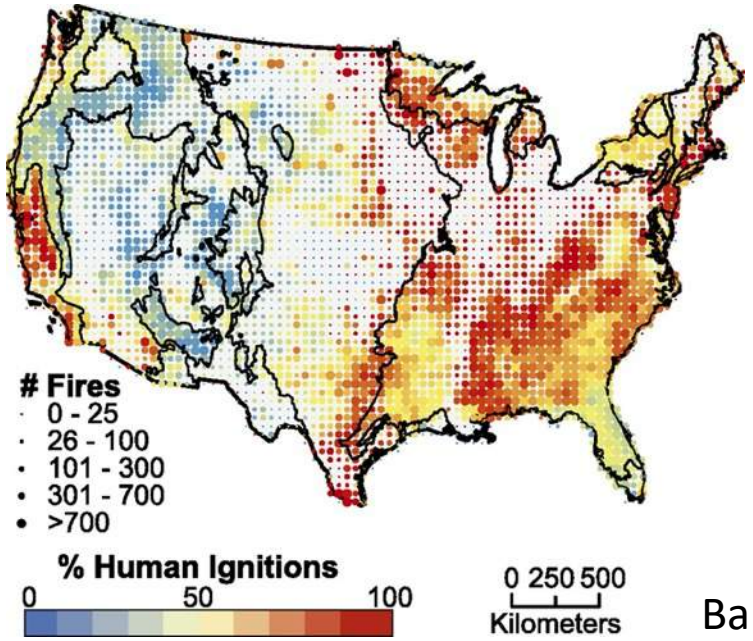




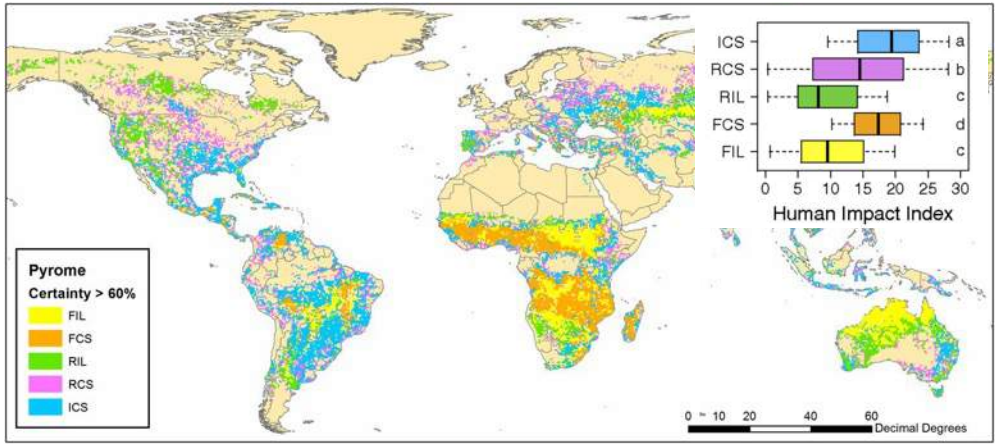
COVID19 Dashboard
http://earthdata.nasa.gov/covid19

How would COVID19 affect managed fires?

- In the US, people ignite >80% of fires, > 40% of burned area
- In SE, the ‘pyrome’ is ‘intermediate–cool–small’, known to be heavily influenced by management (also extends to Europe)
- Informal conversations (spring 2020) that fire programs were closing (worker safety, air-quality/health concerns…)
- In March 2020, we began tracking active fires using data from NASA Fire Information for Resource Management System (FIRMS)
- Work supported by NASA’s Rapid Response Program.



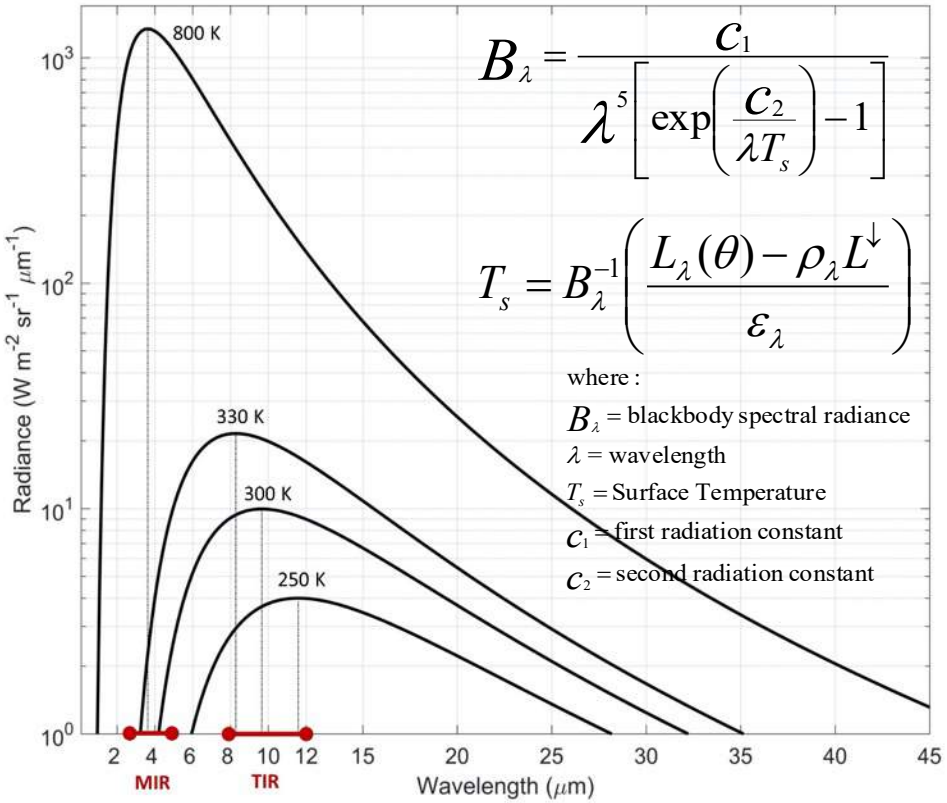
Balch et al. 2017



Archibald et al. 2013


NASA EARTH FLEET
OPERATING & FUTURE THROUGH 2023
SWOT (CNES)
LANDSAT-9 (USGS)
SENTINEL-6 Michael Freilich/B (ESA)
TROPICS (6)
GEOCARB
NISAR (ISRO)
MAIA
TSIS-2
TEMPO
PREFIRE (2)
PACE (NSO)
GLIMR
ICESAT-2
GRACE-FO (2) (GFZ)
CYGNSS (8)
NISTAR, EPIC (DSCOVR/NOAA)
CLOUDSAT (CSA)
TERRA (JAXA, CSA)
AQUA (JAXA, AEB)
AURA (NSO, FMI, UKSA)
CALIPSO (CNES)
GPM (JAXA)
LANDSAT 7 (USGS)
LANDSAT 8 (USGS)
OCO-2
SMAP
SUOMI NPP (NOAA)
INVEST/CUBESATS
RainCube
CSIM-FD
HARP
TEMPEST-D
CIRiS
CTIM
HyTI
SNoOPI
NACHOS
ISS INSTRUMENTS
EMIT
CLARREO-PF
GEDI
OCO-3
TSIS-1
ECOSTRESS
LIS
SAGE III
JPSS-2, 3 & 4 INSTRUMENTS
OMPS-Limb
LIBERA
11.2.20
(PRE) FORMULATION
IMPLEMENTATON
PRIMARY OPS
EXTENDED OPS

Efficiency of Active Fire detection: emissivity



$$B_\lambda = \frac{c_1}{\lambda^5\left[\exp\left(\frac{c_2}{\lambda T_s}\right)-1\right]}$$

$$T_s = B_\lambda^{-1}\left(\frac{L_\lambda(\theta)-\rho_\lambda L^{\downarrow}}{\varepsilon_\lambda}\right)$$

where :

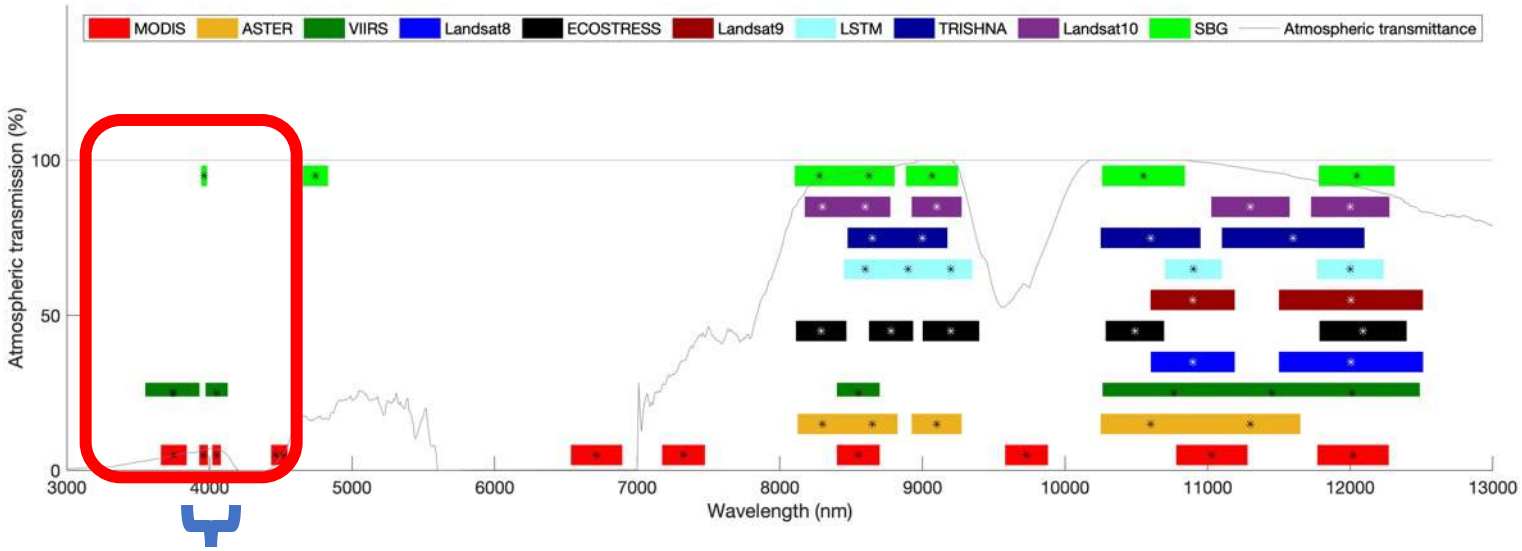
B_λ = blackbody spectral radiance

λ = wavelength

T_s = Surface Temperature

c_1 = first radiation constant

c_2 = second radiation constant

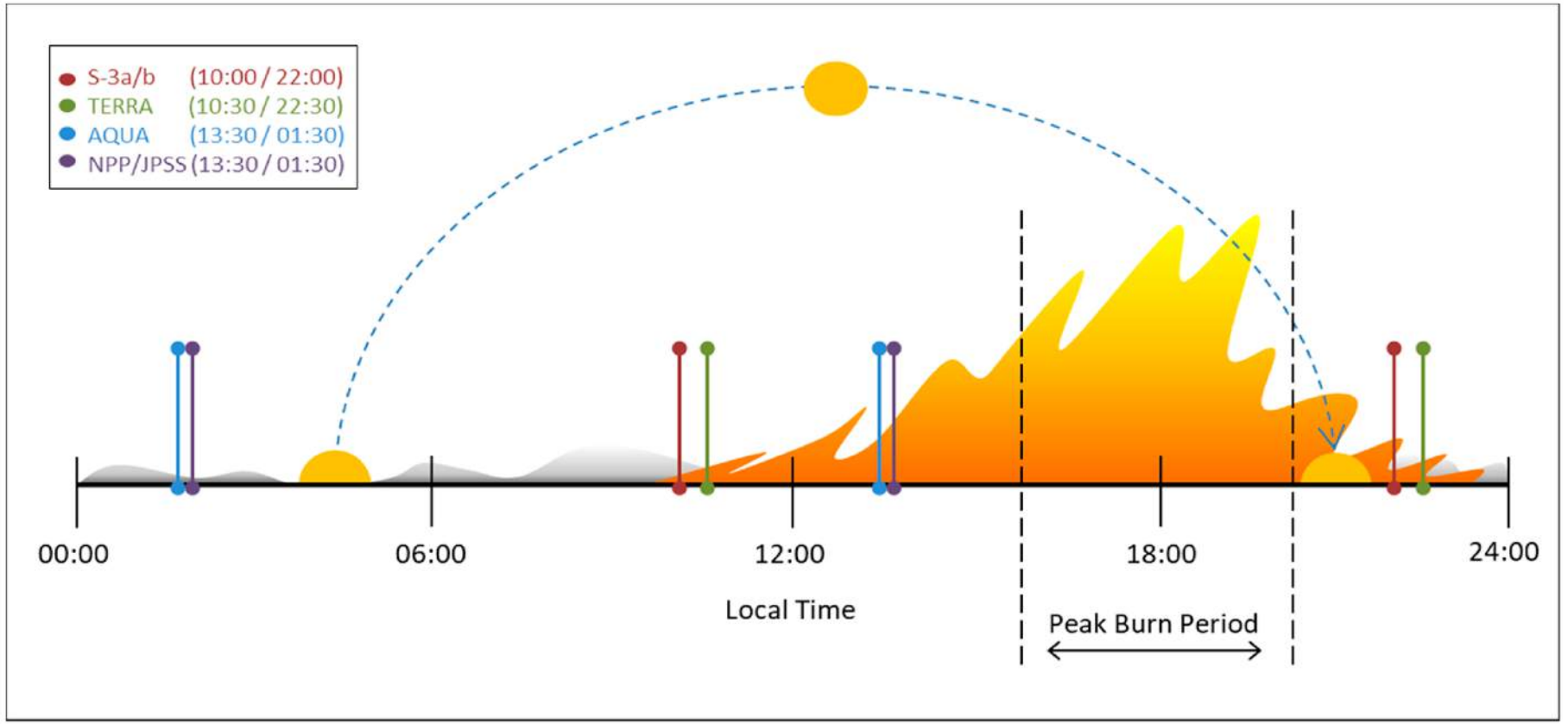


300-1000 K

As the temperature increases the peak in the Planck function shifts to shorter and shorter wavelengths

Efficiency of Active Fire detection: time of day

- Limited options for observing late afternoon fires
  - 10:30 or 13:30 daytime overpass, 20:30 or 01:30 nighttime overpass



Johnston et al., 2020

Detecting COVID19 signal in 2020 fire season

Annual Trends

Active Fires Data

- VIIRS
- MODIS (AQUA+TERRA)

Weekly Updates

- Historical & Cumulative AF

User Interface

- Tall Timbers

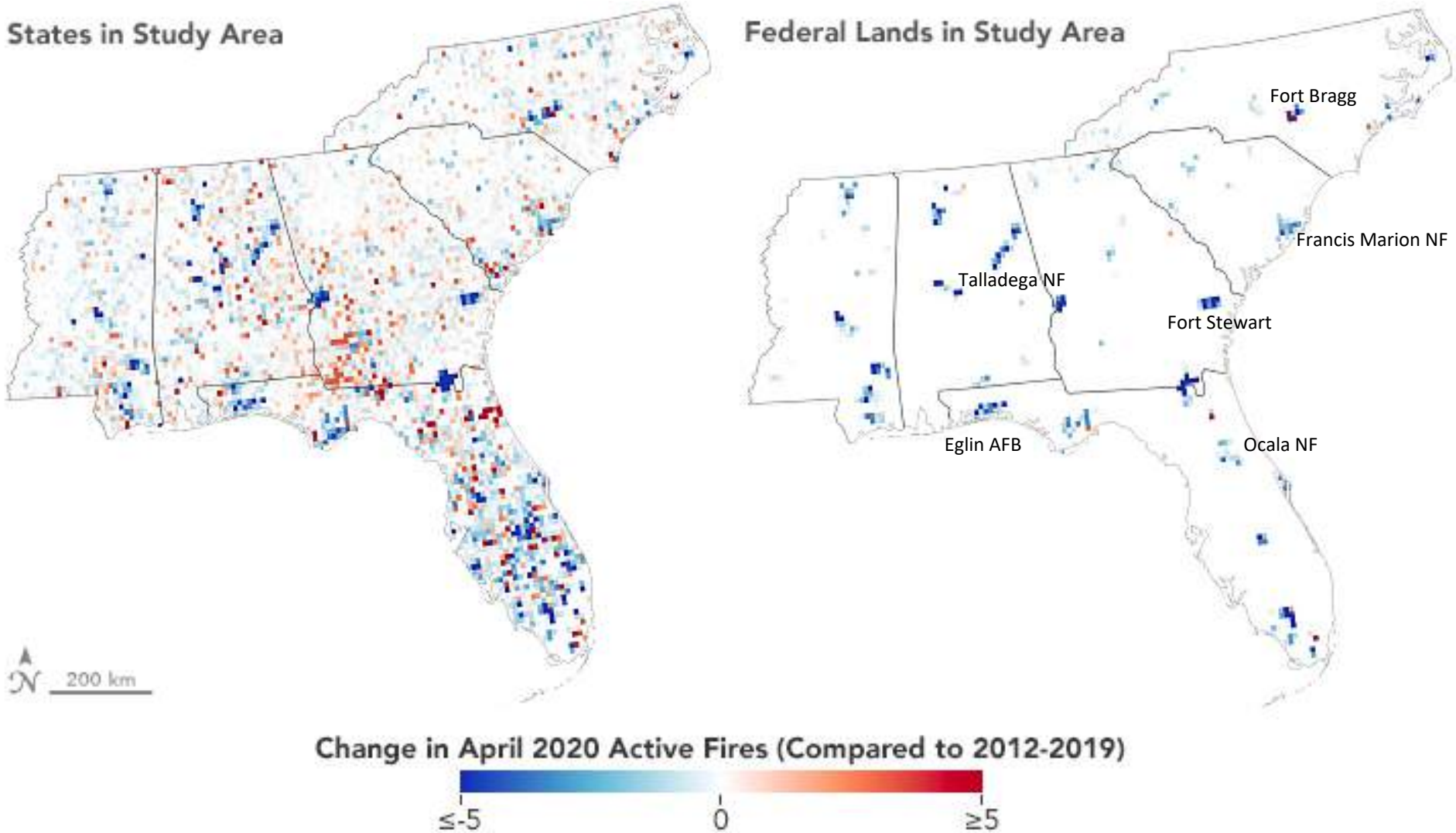
Trends and Drivers

- MERRA2 Reanalysis → KBDI History
- IIFTDSS (FACTS+NFPORS) + Private Permits
- \+ Ownership

Prescribed Fire Burn Windows

- GEOS S2S 9-Month Forecast
- Spatial Downscaling
- KBDI Forecast + Fire History → Burn Priority

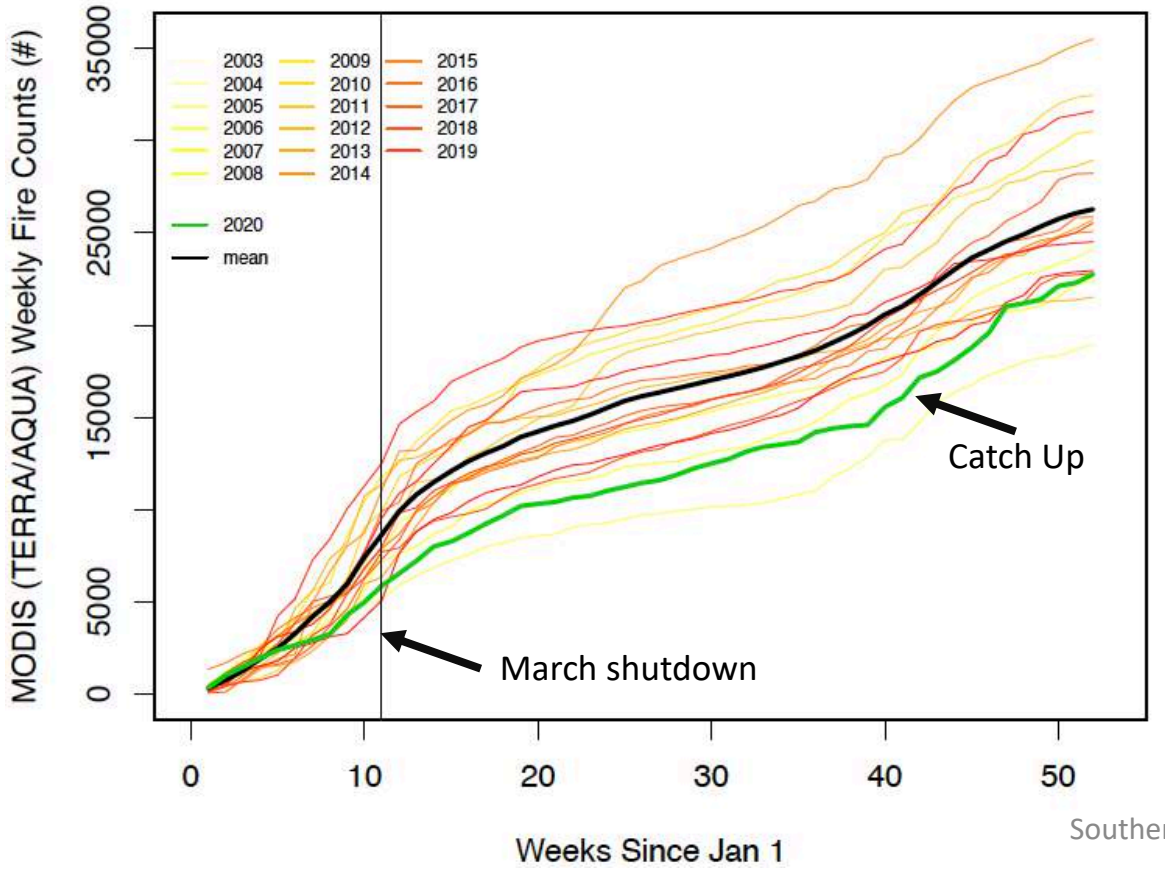
April 2020 – Up to 50% decrease in active fires on public lands



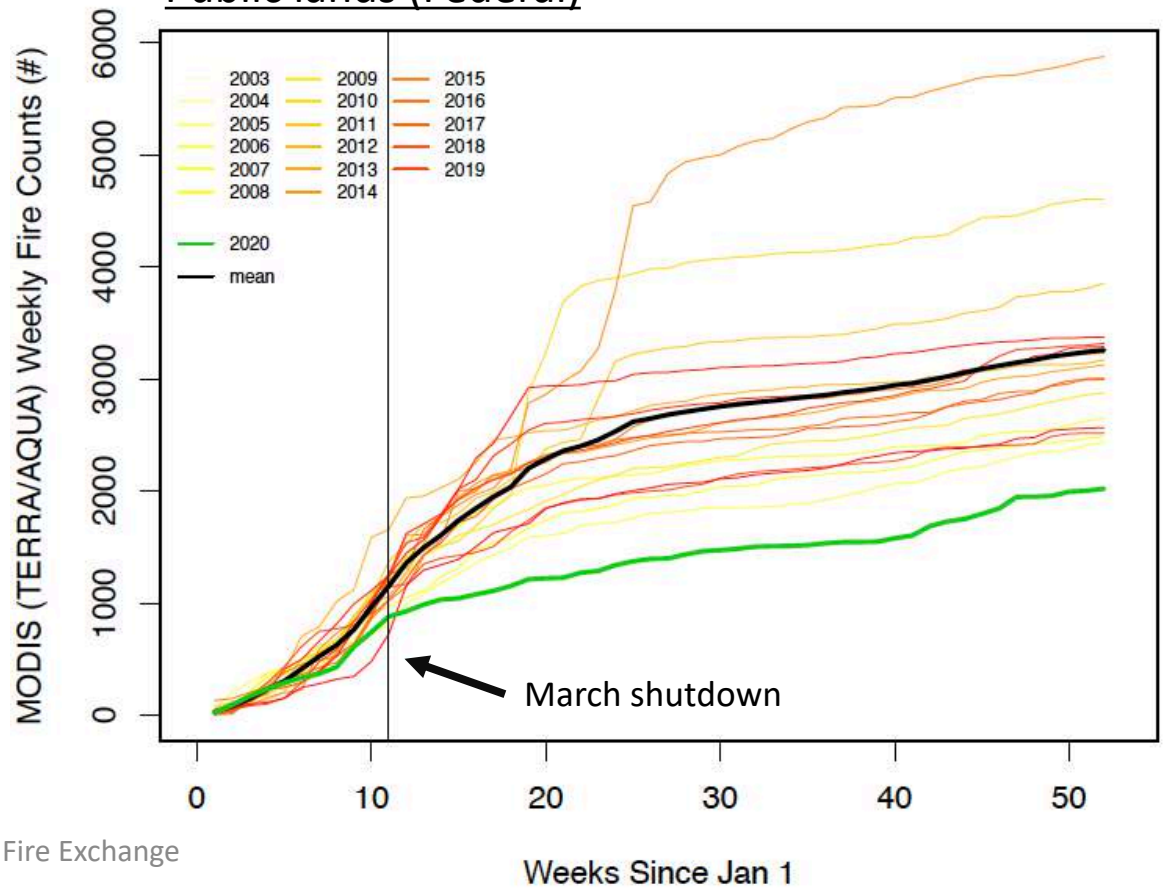
On Federal lands, 2020 was the lowest active fire year since 2000 (and 3rd for all lands)

Cumulative Active Fires in the Southeastern United States (from Jan 1 to Dec 31)

All lands (private and public)

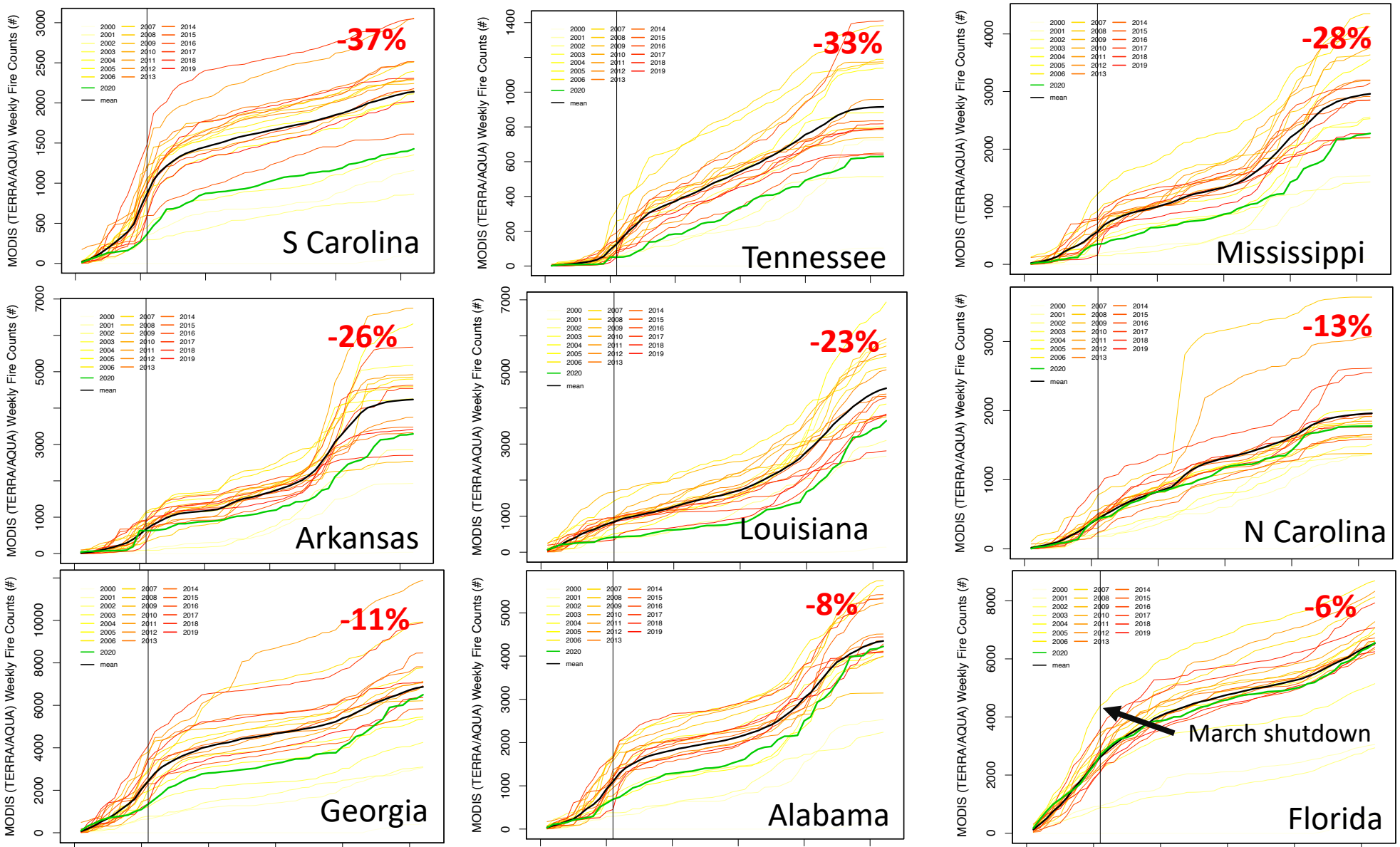


Public lands (Federal)



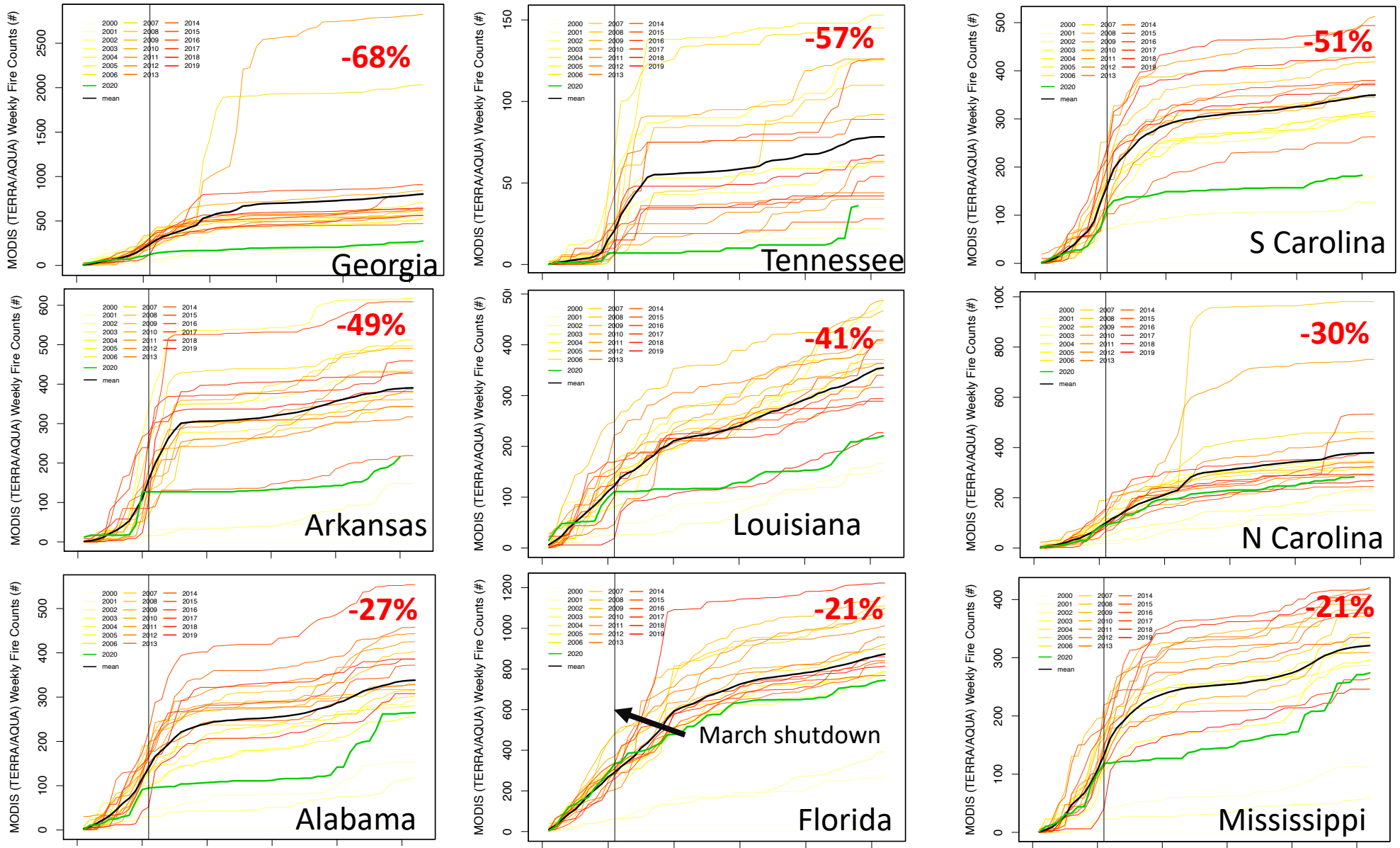
Of nine States, TN and SC had largest deficit. With other states making up lost time in Nov. (eg. AL, MS, GA).

MODIS (AQUA+TERRA)



Federally owned lands generally did not ‘catch up’ at end of calendar year. AL, SC, FL, GA, LO lowest AF since 2000.

MODIS (AQUA+TERRA)

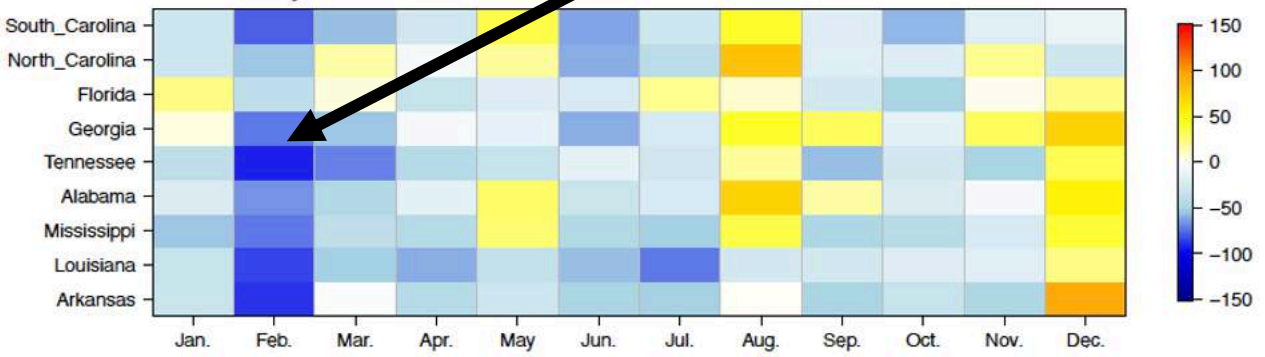


Reductions in (MODIS) AF began in February, and were sustained through Spring-2020 burn season

All land (private + public)

Monthly

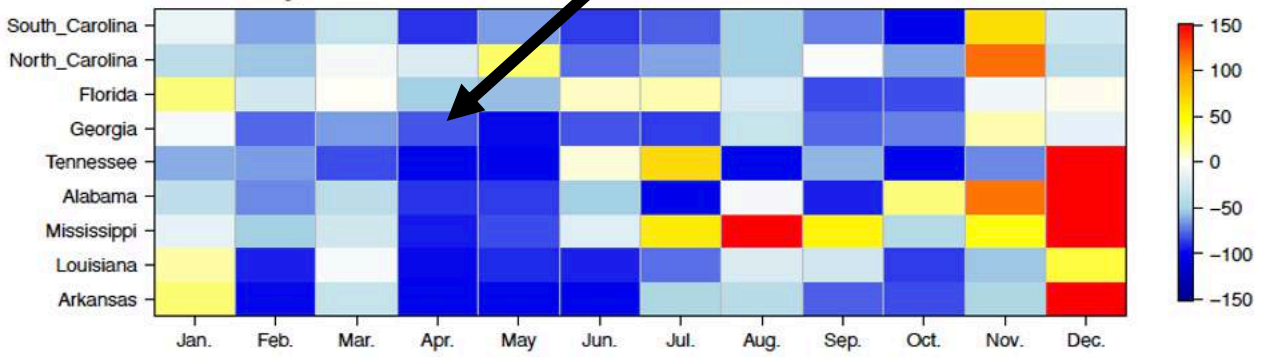
Decrease in fire began in Feb.



Federal lands only

Monthly

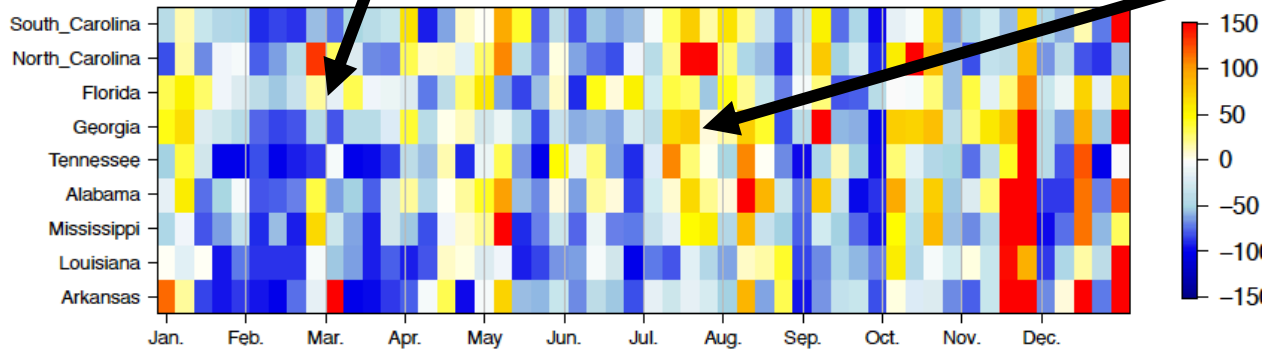
Sustained decrease



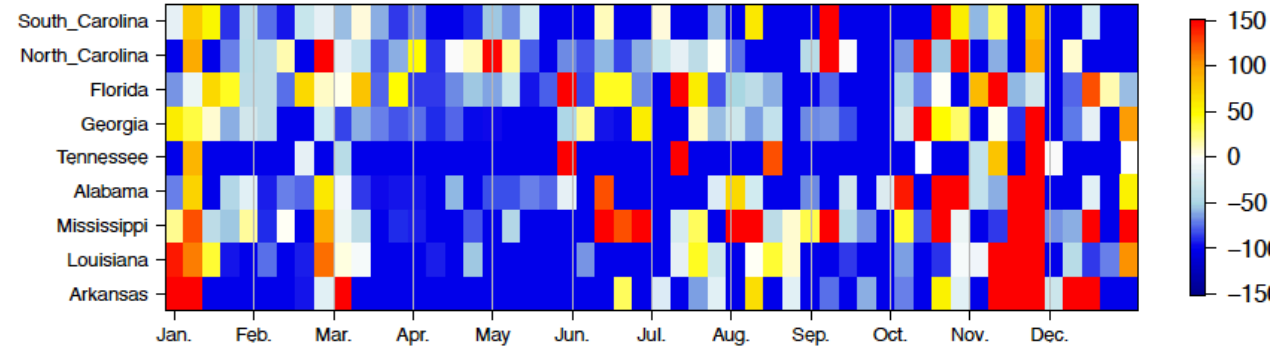
Weekly

Managers went back to burn after Feb. rains

Summer burning



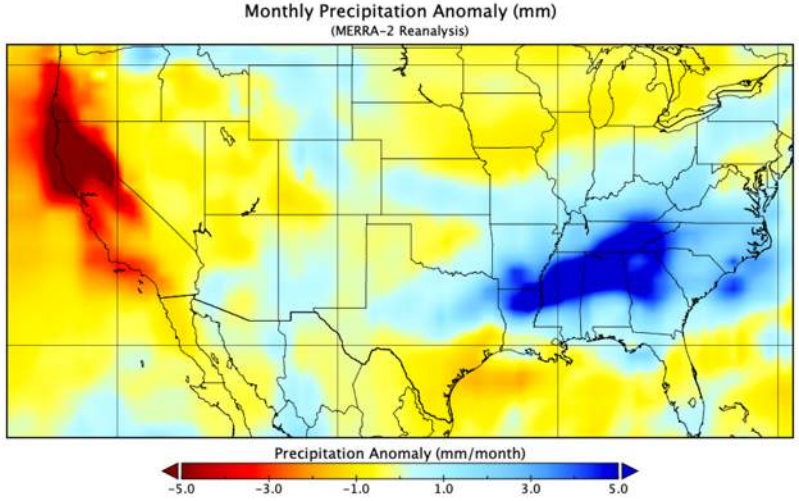
Weekly



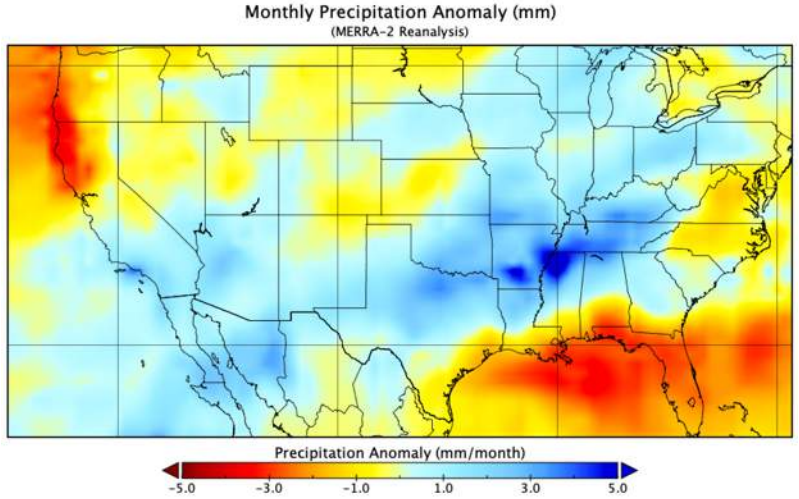
Role of Weather in Active Fire Decline

- A strong cold front (Feb 5-6, 2020) brought moisture from Gulf of Mexico over SE USA.
- Gradual return to precipitation normals, but generally wet spring 2020

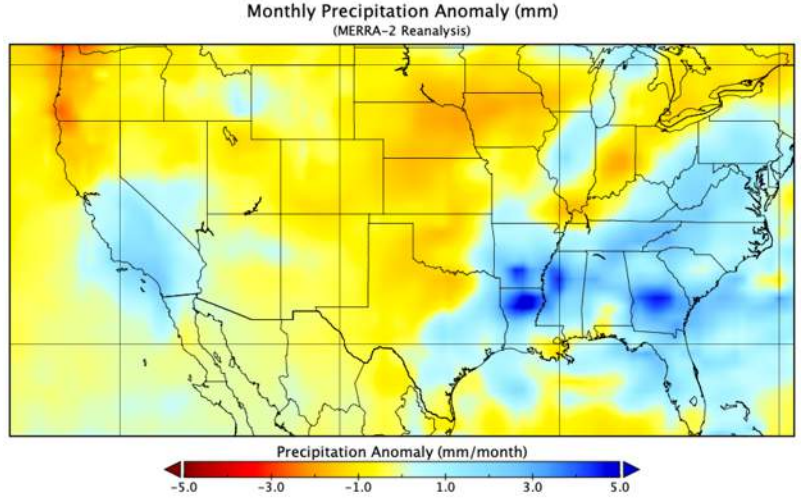
February Precipitation Anomalies



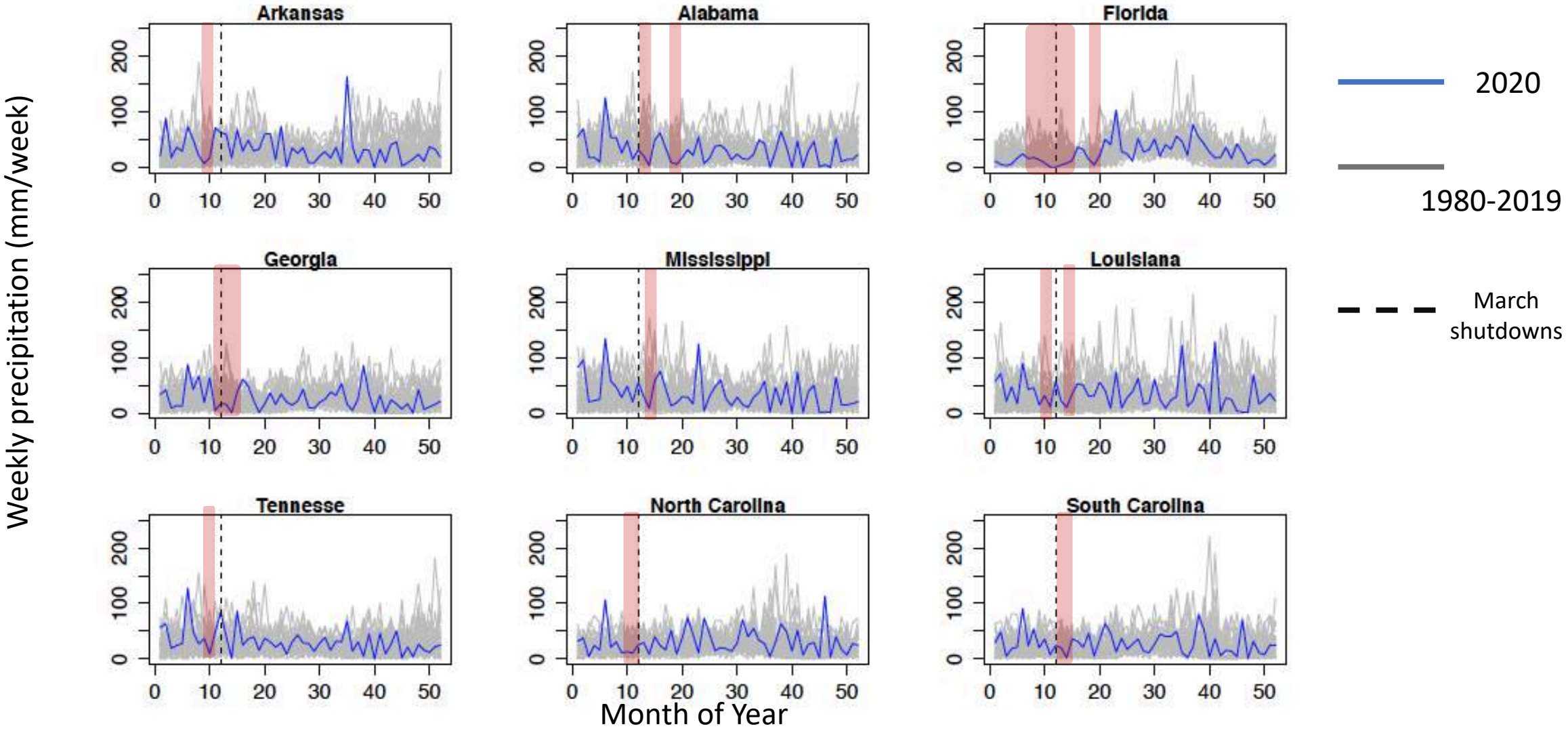
March Precipitation Anomalies



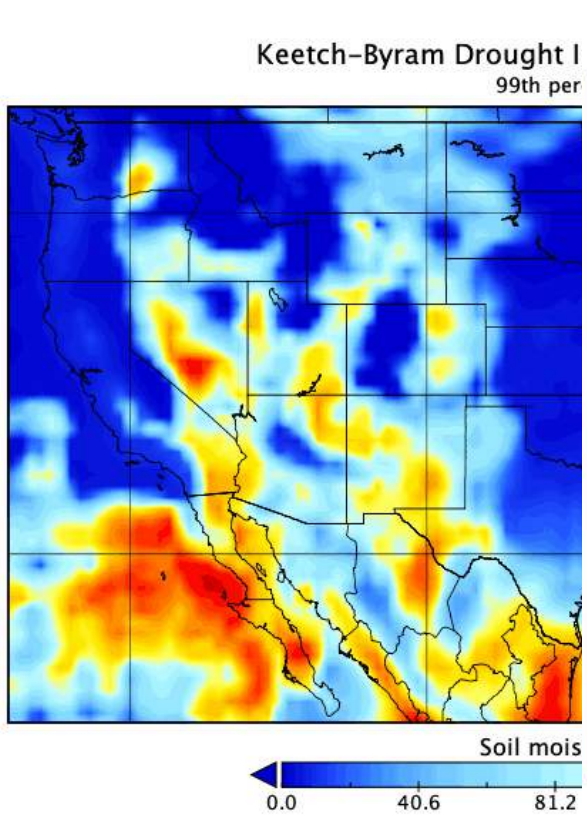
April Precipitation Anomalies

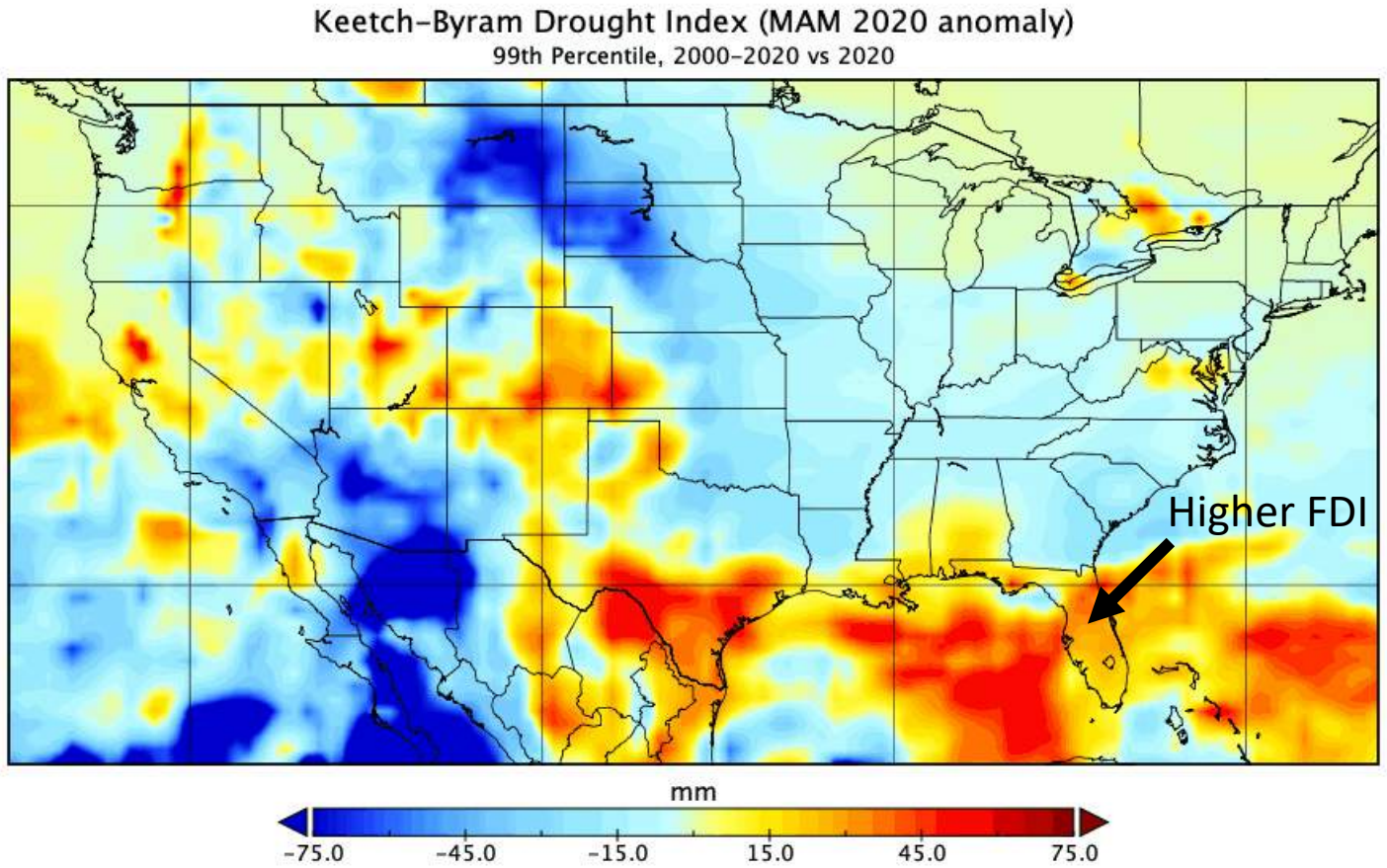


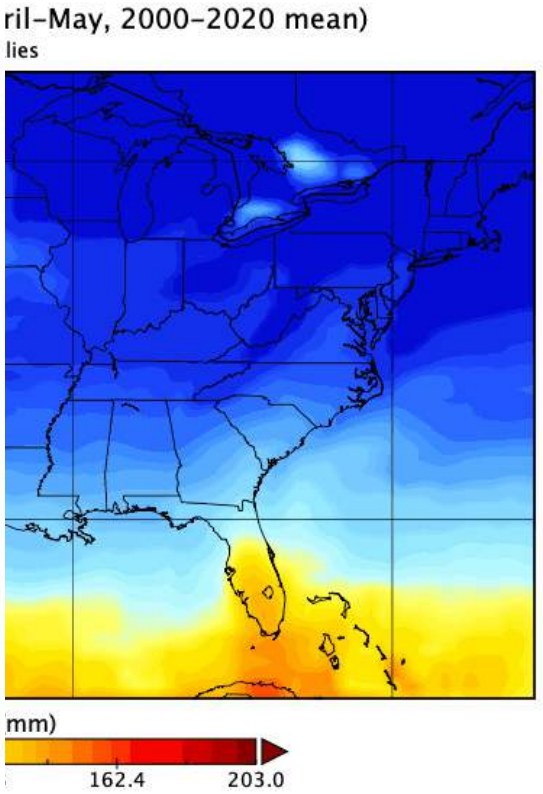
Burn windows emerged during the precipitation events



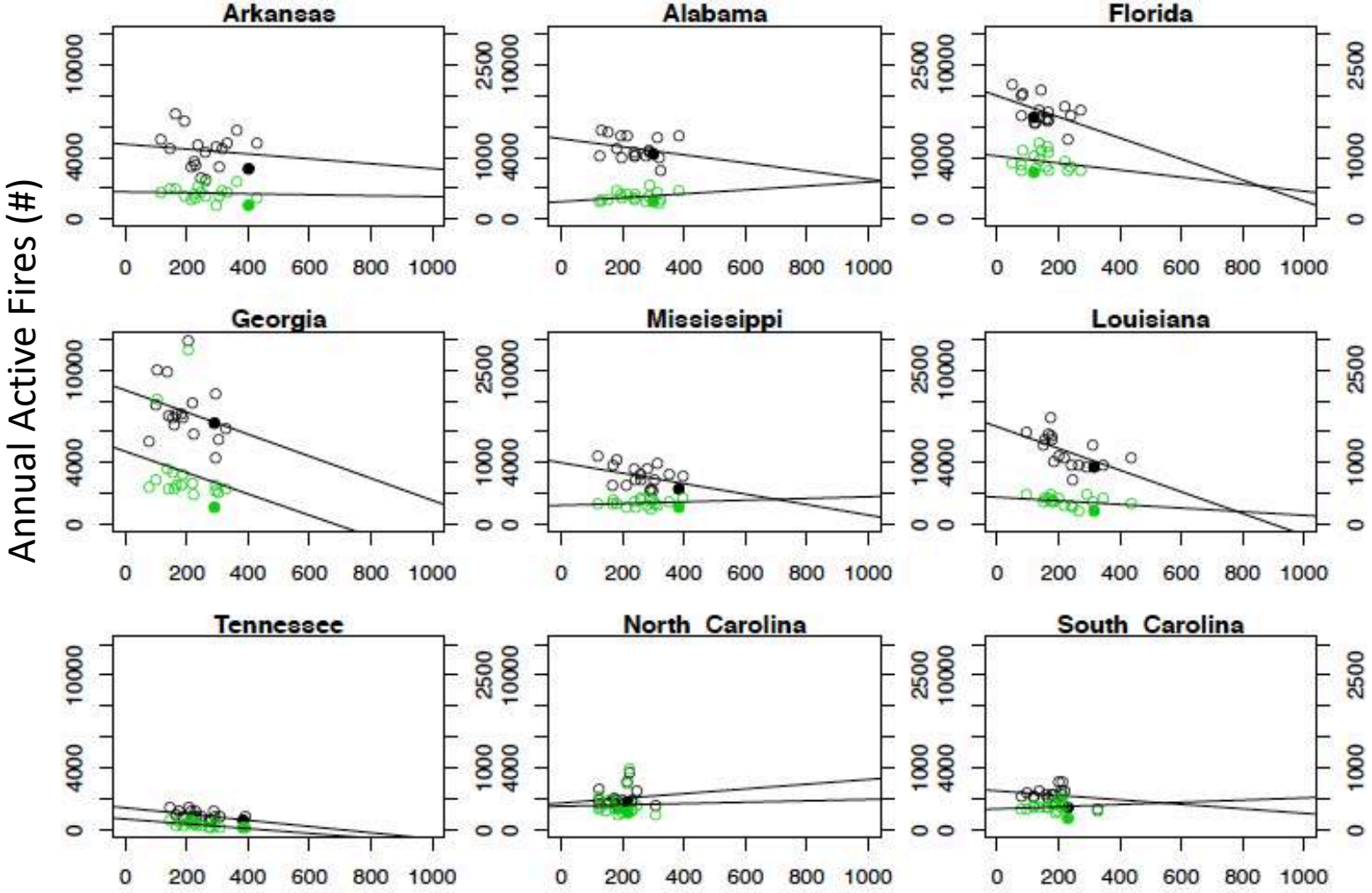
Fire Danger (Keetch-Byram Drought Index) was mostly average for March-April-May 2020







Annual and spring precipitation could predict 2020 annual active fires

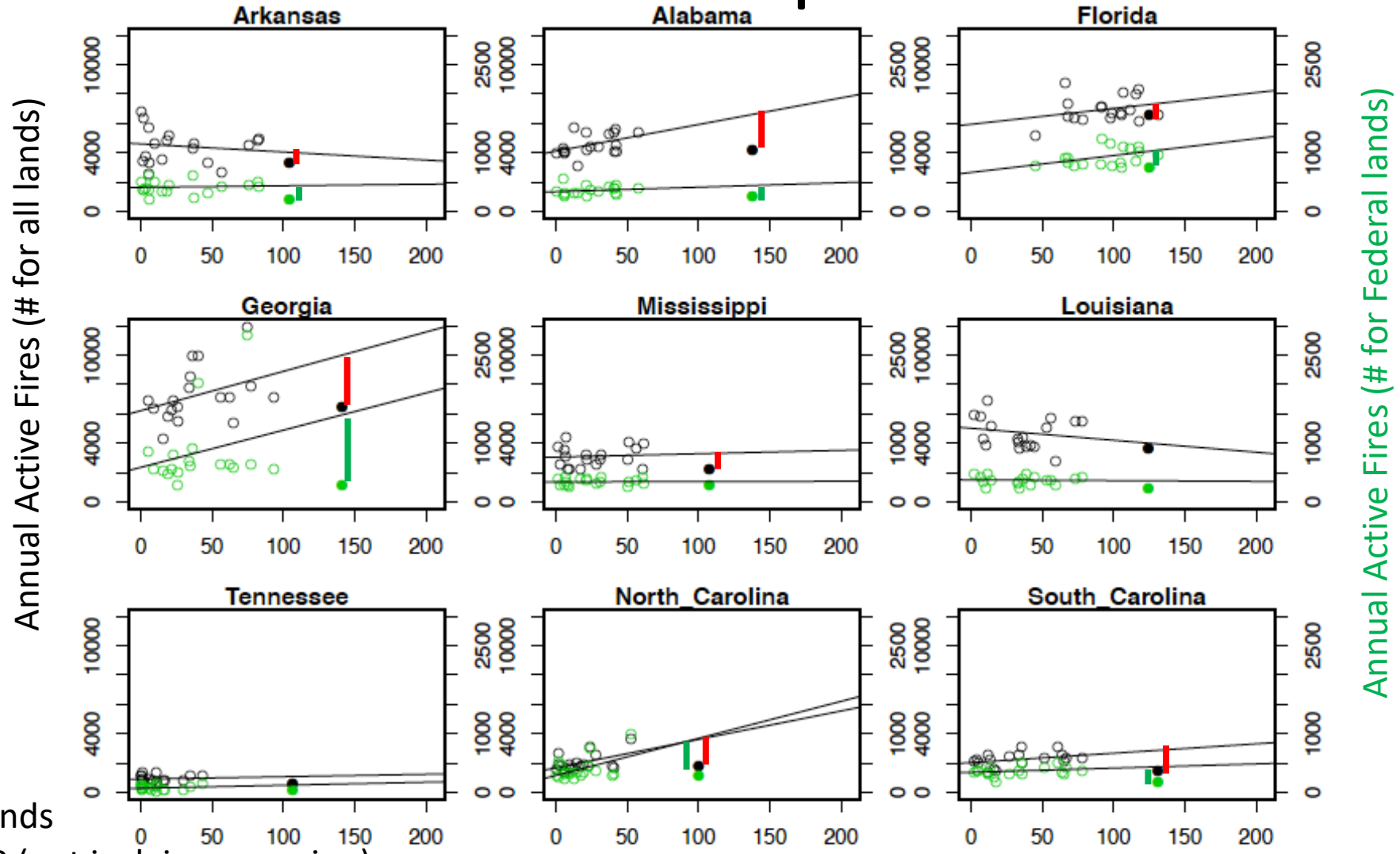


Black = All lands

Green = Federal lands

Filled circle is 2020 (not incl. in regression)

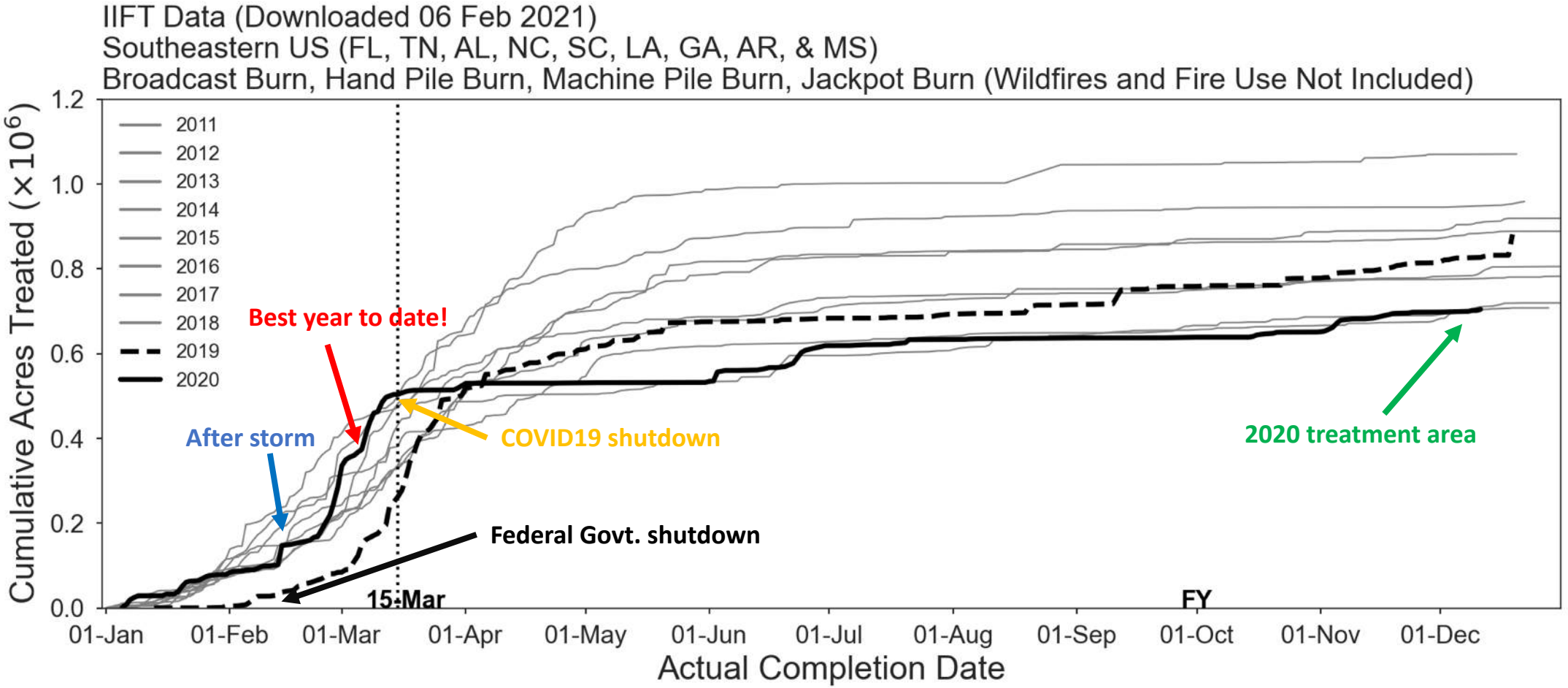
Spring (March-April-May) KBDI predicted a larger number of fires compared to observed



Black = All lands
Green = Federal lands
Filled circle is 2020 (not incl. in regression)

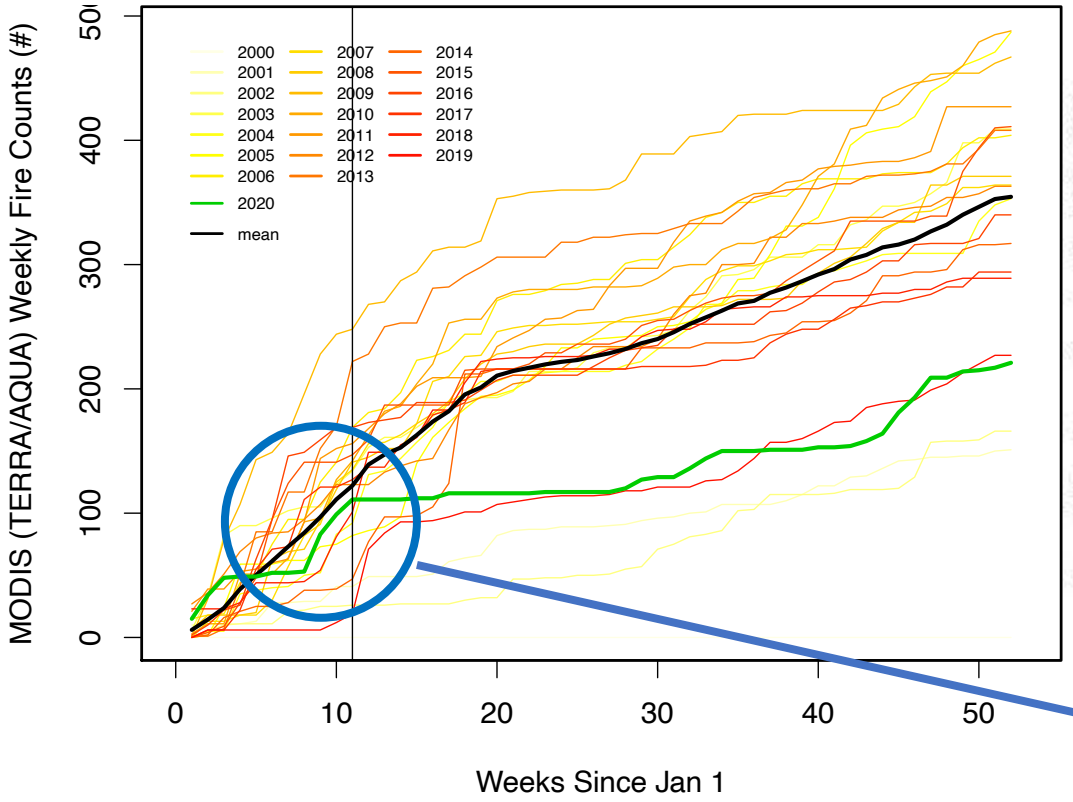
Statistics on Federal fire management confirmed drop in active fire was via reduced prescribed fire

- Data from the Integrated Interagency Fuels Treatment Database (IIFTDSS) combines geospatial fire statistics for Department of Agriculture lands (FACTS; USFS) and Department of Interior lands (NSPORS; BLM, FWS, NPS, BIA). Underreporting, bias is higher <2011 (ignore these years)

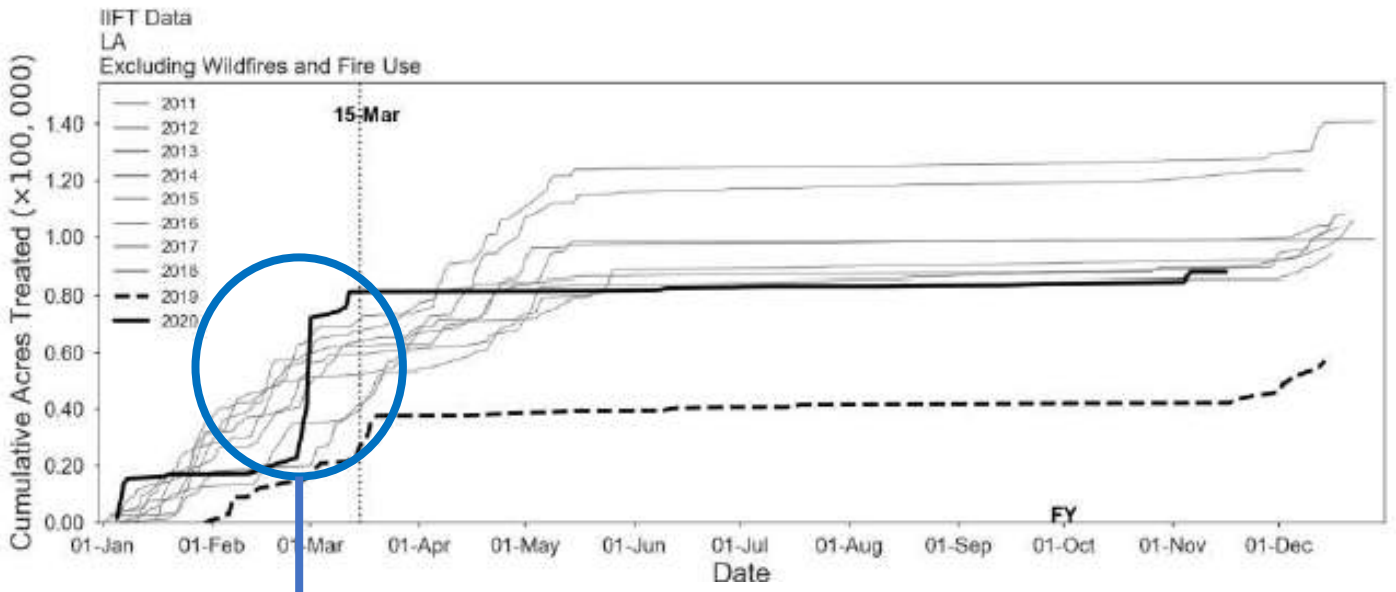


Statistics on Federal fire management confirmed drop in active fire was via reduced prescribed fire

Federal Land active fires for Louisiana



IIFT reporting for Louisiana



Agreement w satellite and statistical reporting

Summary of 2020 fire season

Change in 2020	Percent Change in AF (wrt 2000-2019)	Percent Change in AF (wrt 2012-2019)
Southeast US (public + private)	21% (3rd)	10% (2nd)
Southeast US (Federal land)	41% (1st)	38% (1st)

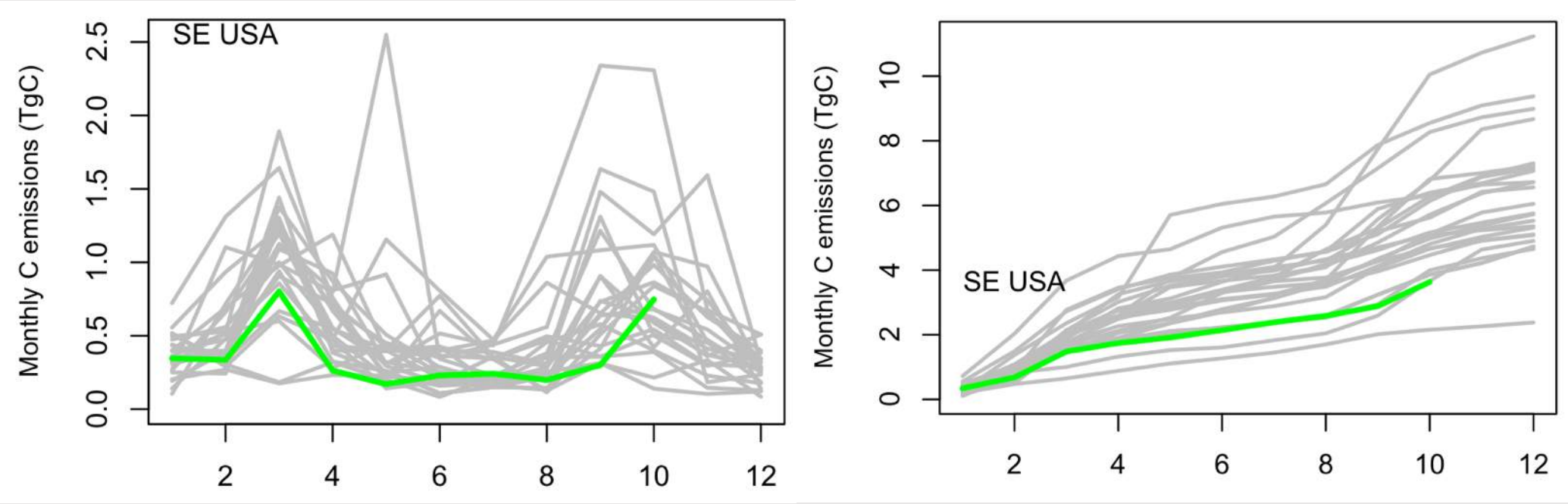
- **Active fire counts lowest since 2000 (MODIS era) and 2012 (SUOMI era) on Federal lands**
- **Georgia had largest decrease on Federal lands (68%) and South Carolina had a decrease of 37% on all lands. Florida decreased by 21% on Federal lands and 6% on all lands.**
- **Satellite detections agreed with IIFTDSS, that reductions were in managed fires.**
- **Burn windows were more frequently used by private and state landowners, including during growing season.**
- **Improvements needed in satellite revisit, redundancy (downlink issue w Aqua), overpass time, spatial resolution**

Photo: Tall Timbers

Implications – short term

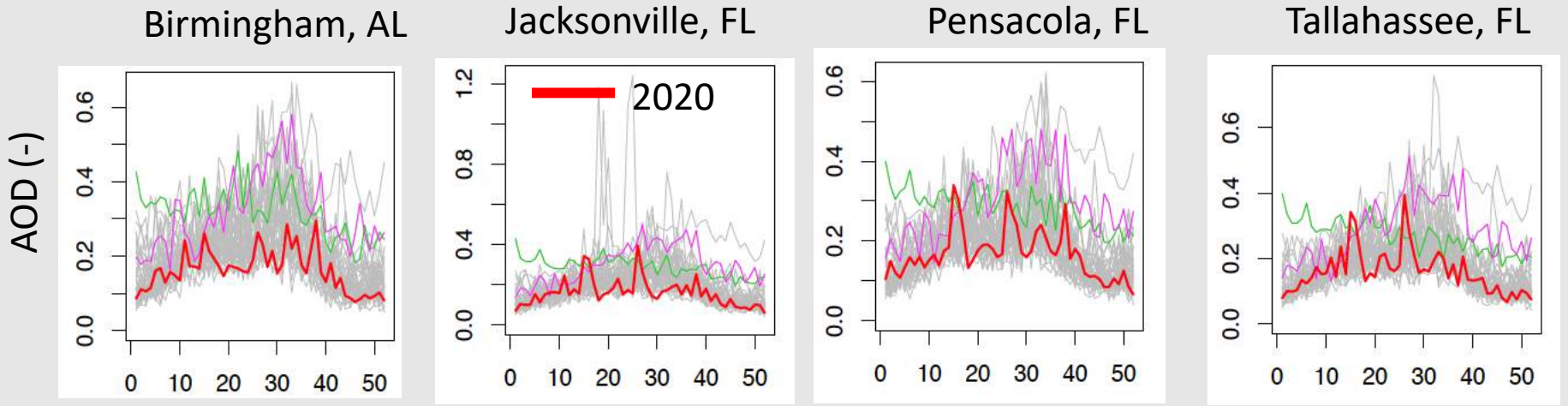
- Air quality impacts, drop in fire trace gas emissions (e.g., CO_2, CO, CH_4)
- Impacts on biodiversity, ecosystem structure and composition

Global Fire Emissions Database (GFEDv4s)

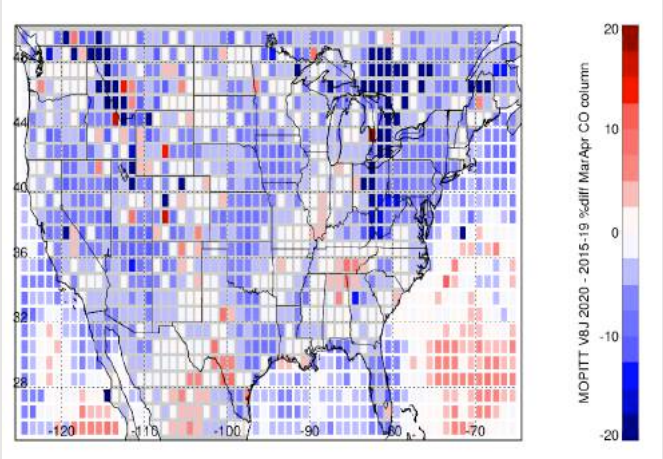


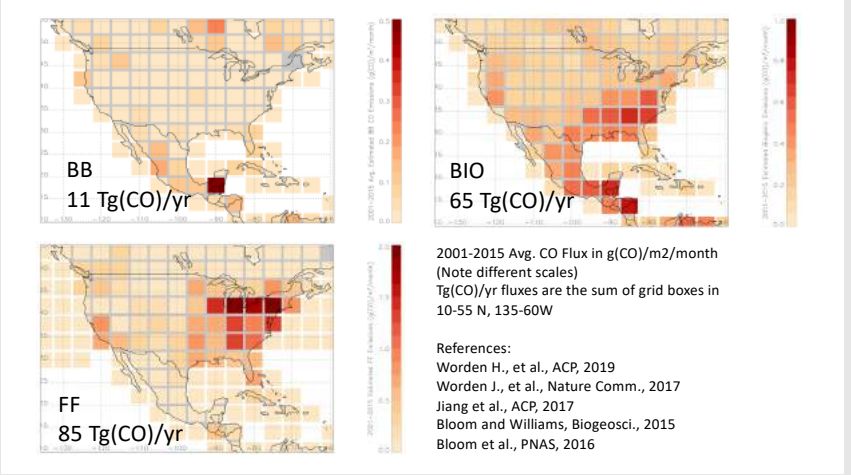
Implications – short term

- Local decreases in aerosol optical depth (AOD), data from MERRA-2 Reanalysis



But no discernable effect on atmospheric CO concentrations

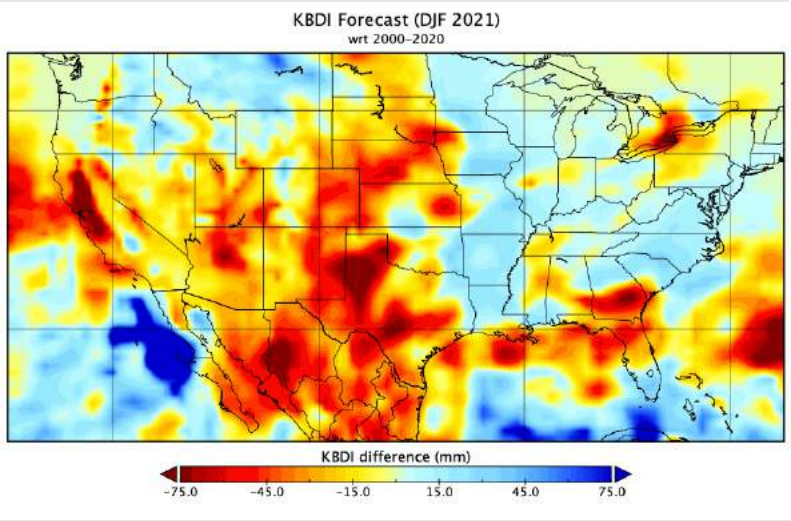




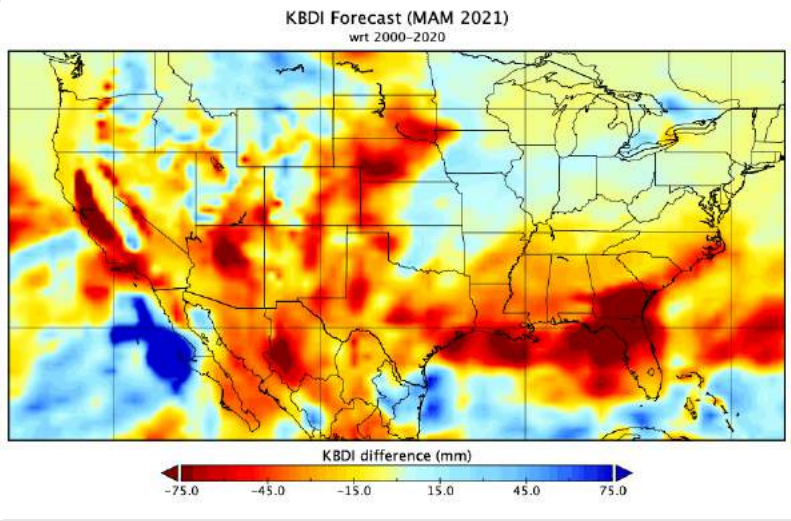
Implications – prioritizing burn windows

- 9-month KBDI 2021 forecasts, combined with fire history, can build priority cases for fire management

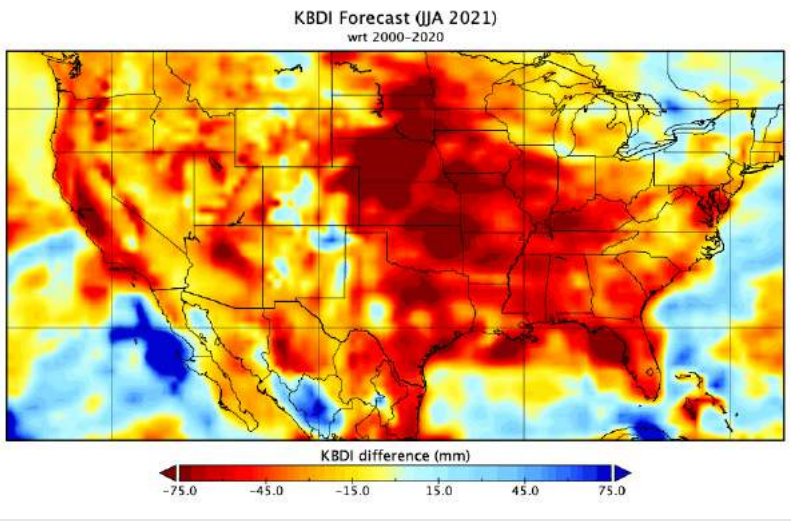
DJF KBDI Anomaly



MAM KBDI Anomaly



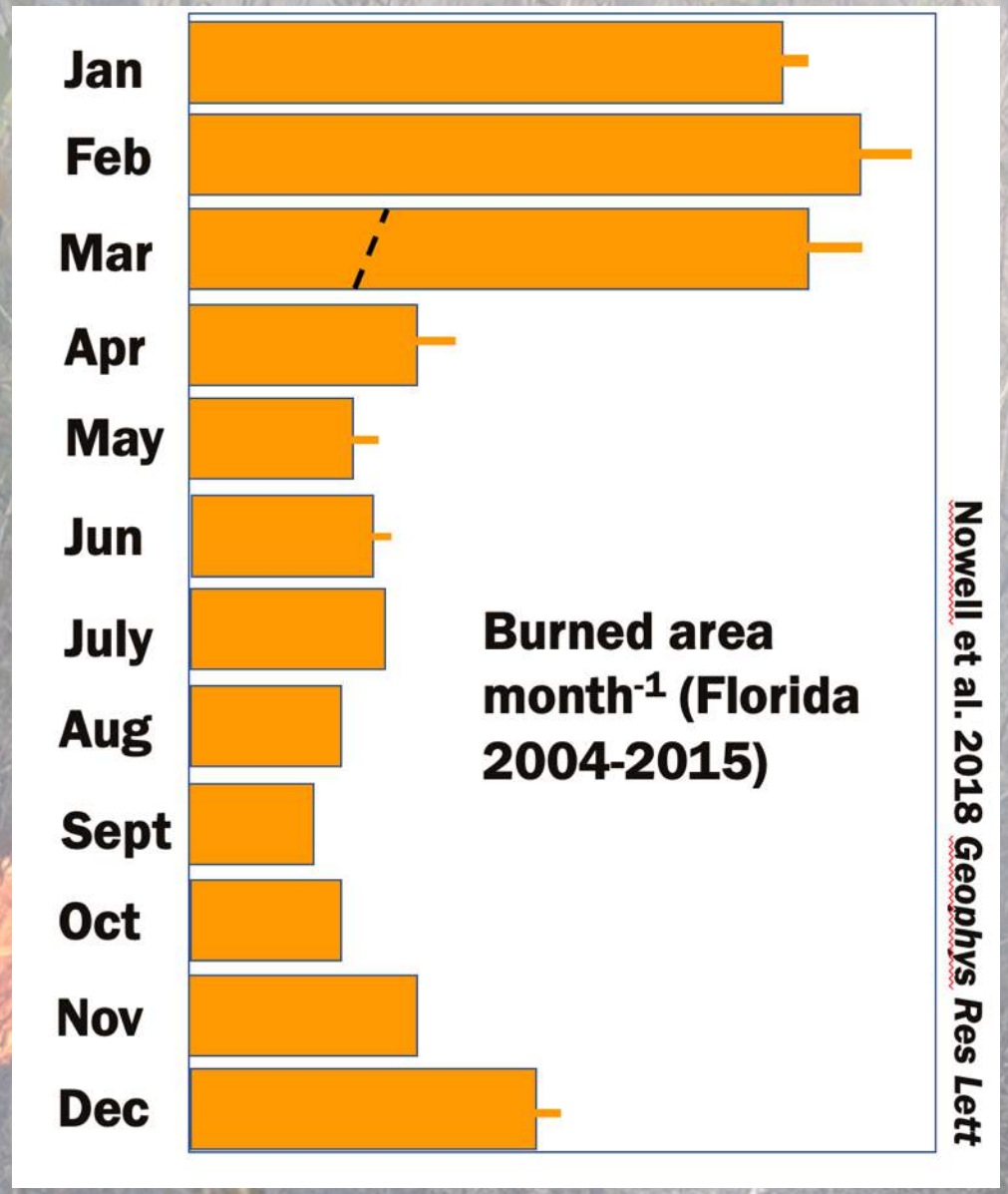
JJA KBDI Anomaly



Implications – long term

- Terrible 2020, tough 2019, and COVID19 continues in 2021
  - How will this complicate 2022, 2023, 2024?

- Fire patterns in 2020 showed managers were opportunistic w burn windows after February storms
  - Growing season burns



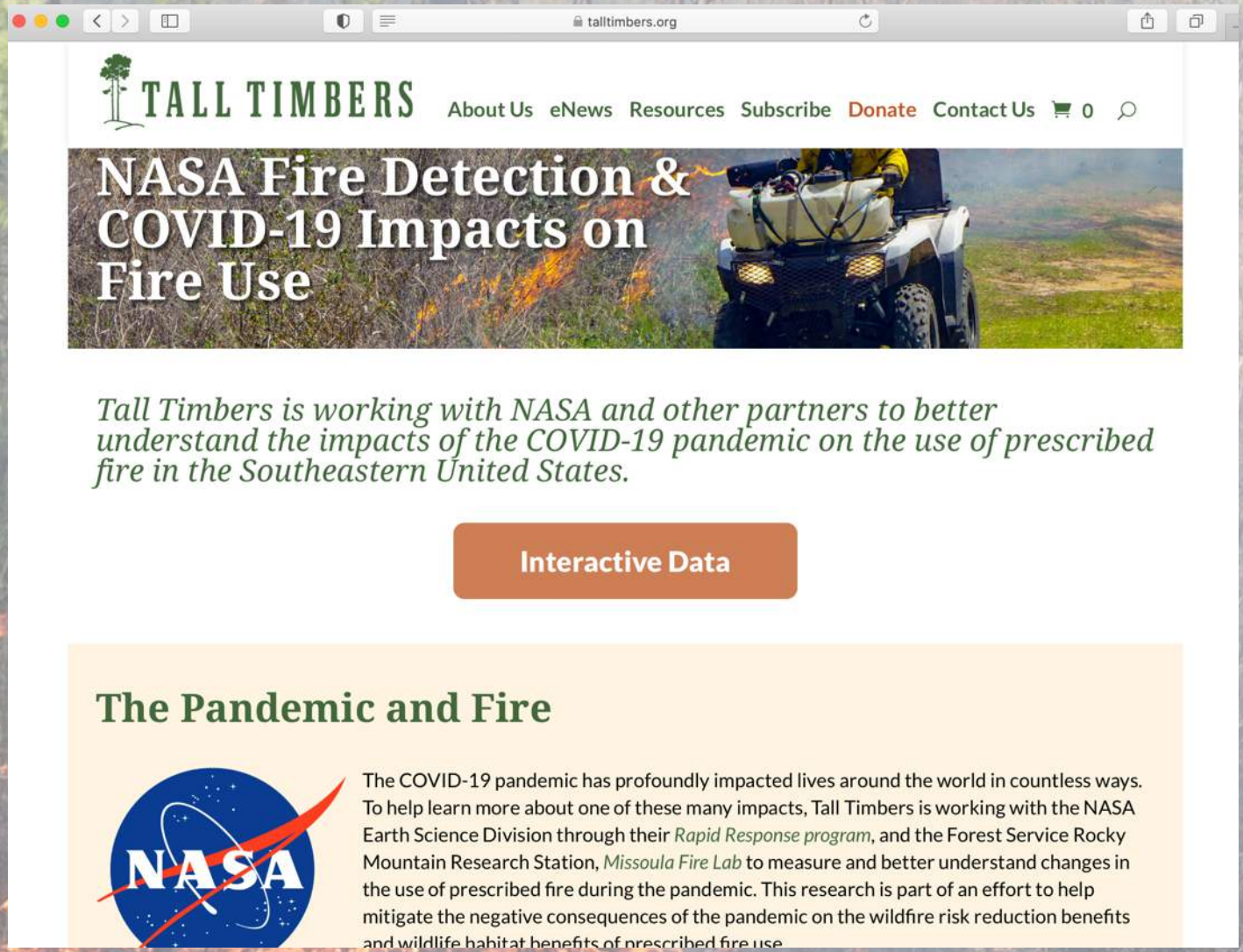
Many important species require frequent fire

Beyond today

- We are interested to hear other experiences beyond the panel

- Email:

fireresearch@talltimbers.org



Interact w 2020 data, and look at trends for 2021
https://talltimbers.org/nasa-prescribed-fire-covid19/